PART II.

Containing similar Descriptions of the Mountain Limestone Series, and other Strata in the N. W. of Yorkshire, with numerous Maps, Sections, and Plates of the Organic Remains, is in great forwardness.

Subscribers' Names for this Part received by the Author, York, till December, 1835.

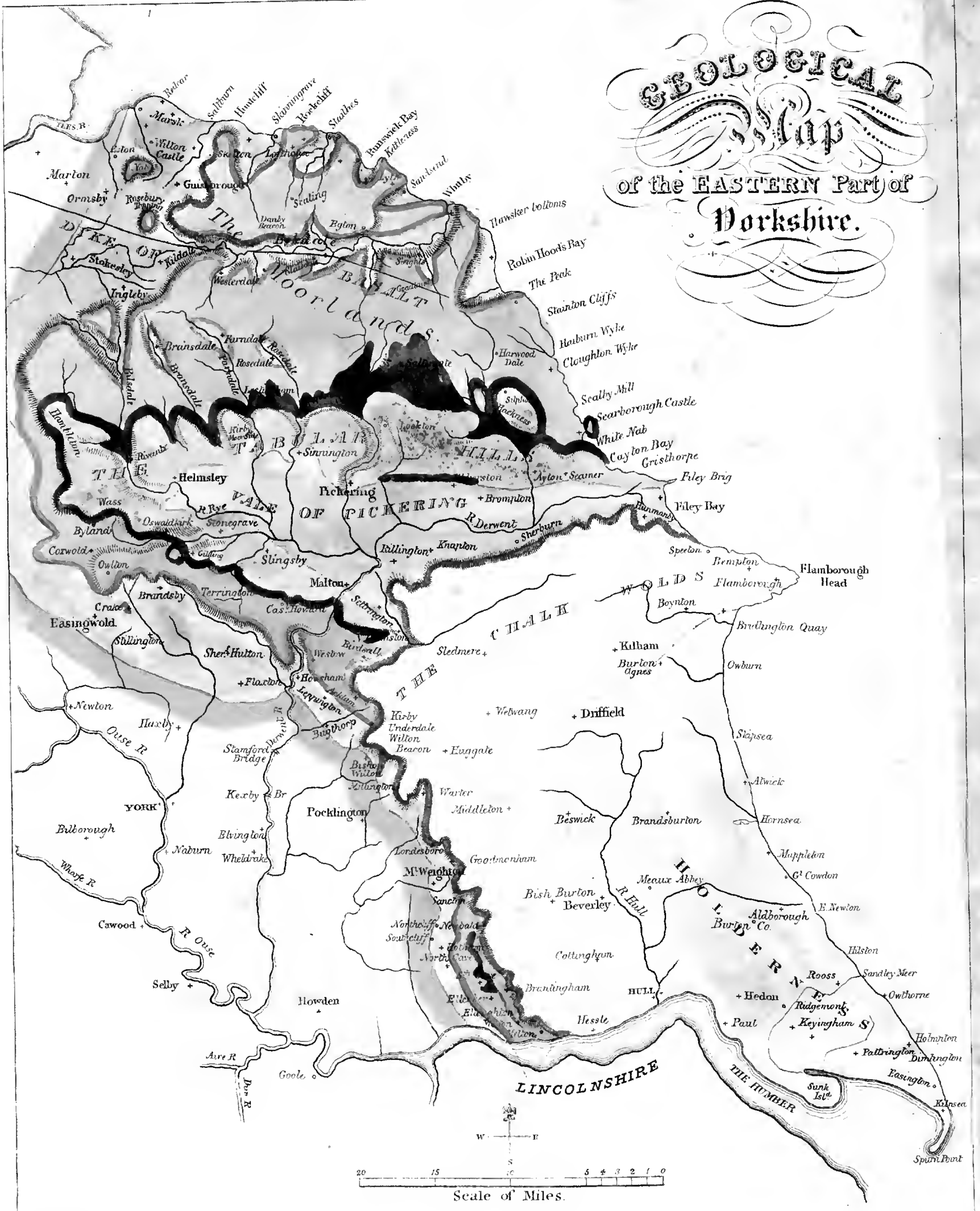
Just Published,

A NEW EDITION

OF THE

GUIDE TO GEOLOGY;

BY PROFESSOR PHILLIPS.



Drawn by J. Phillips

Engraved by Dawson & Brown

ILLUSTRATIONS

OF THE

GEOLOGY OF YORKSHIRE;

OR, A

DESCRIPTION OF THE STRATA AND ORGANIC REMAINS:

ACCOMPANIED BY A

GEOLOGICAL MAP, SECTIONS, AND PLATES OF THE FOSSIL PLANTS AND ANIMALS.

PART I.

THE YORKSHIRE COAST.

BY JOHN PHILLIPS, F. R. S., F. G. S.

PROFESSOR OF GEOLOGY IN KING'S COLLEGE, LONDON; ASSISTANT SECRETARY TO THE BRITISH ASSOCIATION; SECRETARY TO THE YORKSHIRE PHILOSOPHICAL SOCIETY; HONORARY MEMBER OF THE ROYAL GEOLOGICAL SOCIETY OF CORNWALL, THE PHILOSOPHICAL INSTITUTIONS OF YORKSHIRE, LEEDS, HULL, WHITBY, SHEFFIELD, HALIFAX, AND NEWCASTLE-ON-TYNE; OF THE NATURAL HISTORY SOCIETY OF NORTHUMBERLAND, DURHAM, AND NEWCASTLE; OF THE SOCIETY OF ARTS FOR SCOTLAND.

Je ne doute pas, que dans peu d'années peut-être, je ne sois reduit a dire, que l'ouvrage que je termine aujourd'hui, et auquel j'ai consacré tant de travail, ne sera qu'un leger aperçu, qu'un premier coup d'œil jeté sur ces immenses créations des anciens temps.

CUVIER, OSSEMENS FOSSILES, Tome V. page 487.

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TO

WILLIAM SMITH, ESQ.

WHO HAS SPENT HIS LIFE

IN ESTABLISHING THE

PHILOSOPHICAL PRINCIPLES OF GEOLOGY,

AND IN APPLYING THEM, WHEN ESTABLISHED,

TO PRACTICAL USE,

THIS WORK

IS RESPECTFULLY DEDICATED,

BY HIS AFFECTIONATE NEPHEW,

AND GRATEFUL PUPIL,

JOHN PHILLIPS.

CONTENTS.

PREFACE.

THIS New Edition of my first Geological Work differs in some respects from the former one, yet not to such a degree as materially to change the character of the book. The description of the Strata is almost literally the same, and the catalogues of Organic Remains, though amended in particular parts, retain all their original features; but the Synoptic Table has been thrown into a new and more useful form, the plates have been re-engraved with great care, and in some instances improved by more exact copying of the original drawings, a description of the highly interesting ossiferous deposit of Bielbecks has been introduced, and the Introductory Chapter which was designed to convey a general view of the state of Geology in 1829, has been omitted, as being no longer necessary or indeed quite appropriate in a topographical work suited to the year 1835.

The labours of M. Ad. Brongniart, Dr. Lindley, and Mr. Hutton have made known some additional species of Fossil Plants discovered by my indefatigable friends, Mr. Bean and Mr. Williamson; these new species are introduced into the Synoptic Table, which is also augmented by synonyms and references.

Two journeys on the Continent, have enabled me to profit by personal inspection of several noble museums, especially those of Bonn and Strasburgh, and the rich private cabinet of M. De Luc. The

foreign localities, assigned to the species of Yorkshire Fossils in the Synoptic Table, are wholly gathered from these examinations, except a few instances quoted from the satisfactory authority of Brongniart, Goldfuss, and Voltz.—One of the most useful results of my intercourse with the latter of these eminent men, was the conviction that in respect of the species belonging to one important genus of Cephalopoda, (Belemnites) almost nothing was known in England, the researches of the late Mr. Miller being the only proof that any attention had been paid to the examination and classification of these curious fossils. I have lately examined with great care the whole series of belemnites in the Yorkshire Museum, in my own and some other cabinets, and the result as far as relates to the Yorkshire fossils is given in the Synoptic Table, and in the other Lists.

A similar examination of a large series of specimens in the cabinets of Mr. Bean and Mr. Williamson, has made me acquainted with several new and curious crustacea, which with other novelties in Fossil Botany and Zoology brought to light by the indefatigable collectors abovenamed and those who are zealously treading in their steps, will be figured in a Supplement, suited to both editions.

INTRODUCTION.

In laying before the Public the fruits of my own researches into the Geology of the Eastern part of Yorkshire, I think myself called upon to notice the light which has been already thrown upon the subject, by the labours of those who have preceded me in this investigation.

The first person in England who studied, and who taught others to study, the structure of the earth upon the strict principles of the inductive philosophy, was Mr. Smith. Having provided himself with methods of identifying the strata by an attentive examination of all the circumstances which distinguish the one from the other, and especially by a comparative survey of their organic contents, he extended his observations to districts far distant from that in which they were originally commenced, and fixed at length, on a substantial basis, the important doctrine of general formations.

In was in 1794, that Mr. Smith first saw the wolds and moorland hills in the eastern part of Yorkshire; and, guided by the knowledge which he had even then acquired of the correspondence of contour between different portions of the same strata, he decided at once, on a distant view, that the wolds were composed of chalk, and that the moorlands belonged to the oolitic series of rocks. This opinion was fully expressed in his manuscript Map of the Strata of England, for the publication of which proposals were issued in 1800.

The coast was afterwards further examined by him in 1813: in 1817, I had the advantage of accompanying him to Whitby and Scarborough, and was much occupied there with him also in 1820. In his Geological Map of Yorkshire, published in 1821, the lines of chalk, Kimmeridge clay, and coralline oolite, are traced with considerable accuracy, but the lower beds are erroneously named, owing to the anomalous character of the strata, which in this district represent the oolites of Bath. The error, however, was quickly discovered by Mr. Smith, and corrected in several copies of the map which I coloured for his friends. In the same year he shewed me some fossils * collected by him near Scarborough, which I immediately recognised as belonging to the Kelloways rock; but so cautious is this experienced geologist in the application of his own rules, that he scrupled to rely on such evidences of identity between two points so distant as the localities in Wilts and in Yorkshire; and it was not until 1824, that he satisfied himself by a re-examination of the cliffs at Scarborough, with a particular view to their relations with other rocks, of the distinct existence there, both of this and of most of the other members of the series which lies between the coralline oolite and the lias.

Having now obtained a correct view of the stratification of the whole coast, he laid down the details of his observations on the map, and communicated them in conversation to his friends; but the only account of these discoveries which has been published, was in the notice taken of them in the Report of the Yorkshire Philosophical Society for 1824, and in a paper † on the Geology of Cave, which contains an

* Ammonites calloviensis, ammonites Kœnigi, and the small variety of gryphæa dilatata.

† Annals of Philosophy, for June, 1826.

account of the continuation of this range, examined by the Rev. Wm. V. Harcourt and myself, where it emerges from under the chalk hills.

Whilst Mr. Smith was occupied in these researches, it was my good fortune to receive the directions of the Yorkshire Philosophical Society to arrange, as accurately as possible, in the order of stratification, the fossils in their extensive collection. I was delighted to find, in the prosecution of this duty, innumerable proofs of the truth of Mr. Smith's views respecting the distribution of organic fossils, and saw very clearly that many of the strata in the north-eastern part of Yorkshire might be confidently identified with well-known formations in the south of England. For this purpose, I drew up several comparative catalogues of fossils, which, under an amended form, will be found in the following pages. I began also in 1824, with the advantage of Mr. Smith's society on the coast, the Section which is now submitted to the public; and having engaged to deliver an extended course of Lectures on Geology before the Philosophical Societies of Yorkshire, Leeds, and Hull, I resumed the task in the autumn of 1825, and measured and examined in detail all the cliffs from Redcar to Bridlington. The Section, which I was thus enabled to draw on a very large scale, was exhibited and minutely explained to the members of these institutions; it was shewn to Mr. Murchison on his way to Brora; and a copy of it was used by M. M. Oeynhausen and Von Dechen in their examination of the Yorkshire coast.

In October, 1827, I again surveyed and measured the whole coast from Redcar to Scarborough, and prepared sections of certain parts for M. Adolphe Brongniart, as well as drawings of some remarkable fossil plants; and in June, 1828, the labour of admeasurement was

repeated along the entire line, from Dimlington heights in Holderness, to Redcar.

It will thus appear that no pains have been spared to copy the natural sections of this coast as perfectly as possible; and when it is added that, to complete my knowledge of the subject, I have assiduously investigated and measured the interior of the country, have drawn upwards of four hundred species of fossils, and examined above a hundred more, having received the most liberal and ample assistance from my intelligent friends Mr. Bean and Mr. Williamson of Scarborough, and several other collectors on the coast, and geologists in different parts of the county; it will not, I hope, be thought that this work has been attempted without sufficient materials to render it useful.

The strata which I have undertaken to describe, have received the notice of several eminent geological writers; they have been, in some degree, illustrated by the general map of Mr. Greenough, and by the remarks of Mr. Conybeare, in his outlines of the Geology of England; by the comparative view which Mr. Murchison has given of the analogous strata discovered at Brora; and by Professor Sedgwick's paper * on some parts of this district, in which he has shewn the identity of the alum shale of Whitby with the lias of Dorsetshire, and of the Scarborough oolite and its subjacent sandstone with the coralline oolite and calcareous grit of the southern counties, and has successfully compared the substratum of the vale of Pickering with the Kimmeridge clay. But these publications are far from embracing the whole of the subject, nor have I borrowed from them any thing but a confirmation of my own deductions. The details of the present work have been

* Annals of Philosophy for May, 1826.

derived from no other source than the personal observation of the author; and the general views which it contains, of the geological relations of the district, have been founded upon those details.

In 1822, a work was published by the Rev. G. Young and Mr. Bird,* of which the object appears to differ very little from mine; and some apology, perhaps, is due from me for entering upon a field of research which may seem to be already occupied. I take this opportunity of acknowledging the descriptive accuracy of the "Geological Survey of the Yorkshire Coast;" but that survey differs from my undertaking in many material respects. I have not only given a general section of the coast, but have measured the heights, and have added sections in detail. It has been my object not only to figure the most remarkable fossils, but to describe every ascertained species, and to construct a complete catalogue of all that have been hitherto discovered on the coast, distributed in the order of the strata to which they belong. But the most essential difference between the two undertakings is this,—that whilst the authors of the "Survey" have contented themselves with assigning the local relations of the strata, I have considered them also in reference to the general system of geology, and have identified them even in their minute divisions, by a close examination and comparative survey, both of their mineral characters and of their organic contents, with corresponding portions of the same strata in other parts of Great Britain. There are

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* Death, after long illness, has prevented this amiable artist from contributing any more to the illustration of the geology of his native county. The distinction which he acquired was of the most honourable kind, gained without the advantages of a liberal education, by the resolute application of a vigorous and original mind. As a painter, Mr. Bird's talents, more fortunately encouraged, might have raised him to eminence; as a geological observer, his merit was conspicuous and original; and his devotion to the subject was proved, by unremitting attention to the phenomena of his neighbourhood during the last fifteen years of his useful life.

instances in which even the local identity of beds cannot be ascertained by their mineral characters and relative position alone, and in some of these my opinion will be found to differ from that of the authors of the "Survey," in consequence of their having rejected the principle of identification by the organized fossils, a principle which I consider as the most important yet established in geological science, and of which I trust that the present work will be found to furnish some new and strong confirmations.

I cannot omit this opportunity of expressing my sincere thanks to the Officers of the Philosophical Societies of Yorkshire, Leeds, Hull, Whitby, and Sheffield, for the liberality with which they have opened to me their rich and valuable museums; to Mr. Bean, Mr. Williamson, Mr. Dunn, and Dr. Murray, of Scarborough; Mr. Ripley of Whitby; Mr. J. E. Lee of Hull; Mr. Cook of York; Mr. Preston, Mr. Salmond, Mr. Smith, and the Rev. L. V. Harcourt; and the proprietors of many private cabinets, who have zealously forwarded my views. To those friends who have kindly interested themselves in the success of my publication, I have endeavoured to prove my sense of obligation by devoting myself to render it worthy of their patronage. But there is one individual whose constant and considerate benevolence, warm encouragement, and valued participation in my geological pursuits, demand my highest thanks; and those only who like me have found unexpected kindness and unmerited attention, can fully understand the feelings with which I mention the Reverend W. VERNON HARCOURT, First President of the Yorkshire Philosophical Society.

CHAPTER I.

Series of Yorkshire strata. Geological description of the eastern part of the county.

Yorkshire is one of the few counties of England which are defined by natural boundaries. On the west it reaches, and in some places extends beyond, the great summit ridge of the island; the Tees is its natural limit on the north, the Dun for a great length on the south, and on the east it is washed by the German ocean. Its area is divided into several obvious sections, distinguished alike by topographical features and geological structure. Along the middle of the county, from north to south, runs a wide level vale, filled with gravel, deposited on the upper red sandstone. From beneath, rises towards the west an elevated undulated tract, of carboniferous and calcareous rocks, which ascend to the summits of Micklefell, Ingleborough, and Pendle Hill; whilst above, on the east, appear the uniform ranges of the chalk and oolite. The hilly western tract is grouped in two portions: the district south of the Aire, in which, generally, sandstones and shales with coal abound; and the more elevated region north of that river, whose romantic dales are sunk into the mountain limestone, and whose hills are capped by the lower members of the coal series.

The eastern part of Yorkshire may be topographically considered in five divisions.—Three of these are conspicuous from their elevation; viz. the open round-fronted wolds of chalk in the south, the flat-topped ranges of oolite in the middle, and the more mountainous groups of shale, sandstone, limestone, and coal, which form the northern moorlands; two are wide, level tracts: viz. the vale of Pickering, which separates the chalk wolds from the oolitic hills, and Holderness, which

is a broad tract of alluvial marshland, undulated by hills of diluvial clay and gravel.

These five divisions of the surface reach the coast in succession, and mark it with very characteristic features. The shore of Holderness is, like the interior, low and undulated; the wolds terminate in long, lofty, and connected cliffs; a depression on the coast marks the line of the vale of Pickering; flat-topped heights characterise the oolitic formation on the shore, as well as in the interior; and the highest precipices on the coast belong to the same series of rocks as the loftiest of the inland hills. It will, therefore, be no unprofitable labour to attempt a connected sketch of the geological characters of the five districts, into which nature has divided the eastern part of this county, before we describe, in greater detail, the sections which they present against the sea. It is, however, necessary previously to exhibit a

TABULAR VIEW OF THE SERIES OF YORKSHIRE STRATA.

Formation	Strata	Utmost thickness. Feet.	Localities
Chalk formation.	1 White Chalk	500	The Wold hills from Flamborough to Hessle.
	2 Red Chalk	5	
Clay vale formation. (SMITH.)	3 Gault ?	150?	Specton, Knapton. Kirby-Moorside, Helmsley, Settrington, Elloughton.
	4 Kimmeridge clay		
Coralline oolite formation.	5 Upper calcareous grit	60	Silpho Brow, Sinnington, Wass Bank.
	6 Coralline oolite	60	Scarborough Castle, Pickering, Malton.
	7 Lower calcareous grit	80	Scarborough Castle, Hambleton end, Malton, Leavening.
	8 Oxford clay	150	Scarborough Castle, Saltergate Brow, Rievaulx Abbey.
	9 Kelloways rock	90	Scarborough Castle, Hackness, Rievaulx Abbey.

Formation	No.	Stratum	Utmost thickness. Feet.	Localities
Bath oolite formation.	10	Cornbrash limestone	10	Gristhorpe, Scarborough.
	11	Upper sandstone, shale, and coal	200	Gristhorpe, Scalby.
	12	Impure limestone, (Oolite of Lincolnshire.)	30	Gristhorpe, White Nab, Cloughton Wyke, Hawsker.
	13	Lower sandstone, shale, and coal.	500	Cloughton, Peak, Burton Head, &c.
	14	Ferruginous beds, (Inferior oolite and sand of Somersetshire.)	60	Peak, Whitby, Boulby, the Cleveland hills.
Lias formation.	15	Upper lias shale	200	Cliffs near Whitby, Hills near Guisborough, &c.
	16	Marlstone series	150	Cliffs near Staithes, Head of Bilsdale, Eston Nab, &c.
	17	Lower lias shale	500	Robin Hood's Bay, Boulby, Redcar.
New red sandstone formation (Werner.)	18	Red marl and red sandstone	thickness unknown.	Yarm, Boroughbridge, and Ferrybridge.
	19	Brotherton limestone	45	From Brotherton to Doncaster.
		Red clay and gypsum	50	Fairburn, Knottingley.
		Magnesian limestone	150	Catterick, Knaresborough, Doncaster, &c.
Carboniferous formation.	20	Coal measures	3000	Leeds, Barnsley, Sheffield.
	21	Mountain limestone series	2000	Swaledale, Yoredale, and Wharfdale.
Slate formation.	22	Slate rocks	thickness unknown.	Ingleton, Sedbergh.

Over these strata, is spread the detritus from diluvial currents, and, in particular places, this is covered by more recent accumulations of peat, clay, &c.

THE MOORLAND DISTRICT.

This district is remarkable for presenting, along its whole outline, a range of bold and steep escarpments. Its overhanging cliffs, which so strikingly characterise the coast between Scarborough and Redcar,

are among the loftiest in Britain; and where it turns inland from Huntcliff, by Rosebury Topping, Burton Head, Dromanby Bank, and Osmotherly moors, it maintains the same high and precipitous aspect, and looks over the plain of Cleveland and Mowbray, as the ranges of Cleeve and Broadway overlook the vales of Gloucestershire. This similarity of appearance is owing to analogy of geological structure. The wide vales of Gloucestershire are, like the vale of Cleveland, based on red marl and lias shale; and the oolitic rocks of Cleeve and Broadway are represented, though with great variations, by the rocks of the corresponding escarpments in Yorkshire.

Including that portion of the vale of Cleveland which is based on the lias formation, this division contains about five hundred and fifty square miles. On the south, it is bounded by the elevated edge of oolitic rocks, which range, nearly in a straight line, from Scarborough castle to Hambleton end. (See the map.) It comprehends the whole drainage of the river Esk, and on the north of that river forms an imperfectly connected range of hills, from near Whitby to Rosebury Topping, with detached secondary elevations on the northern coast, at Rockcliff, Huntcliff, and Eston Nab. According to Col. Mudge, the heights on this range are as follow: Rosebury Topping, one thousand and twenty-two feet; Eston Nab, seven hundred and eighty-four feet; Danby Beacon, nine hundred and sixty-six feet; Easington Heights, six hundred and eighty-one feet. The Esk flows nearly along the line of a great dislocation, by which the strata on the north of the valley are much depressed. It is on the south of this river that we find the most elevated and extensive moorlands. From the cliff at the High Peak, near Robin Hood's Bay, six hundred feet, a range rises and extends westward by Stow Brow, eight hundred feet, Lilhowe Cross, one thousand feet, Egton moors, and Loose Hoe, fourteen hundred and four feet, to Burton Head, fourteen hundred and eighty-five feet. This is supposed to be the highest point of land in the eastern part of the county, but the ridges are still very lofty which pass by Wainstones, about thirteen hundred feet, and Carlton Bank, round the head of Scugdale, and by Osmotherly moors, to sink beneath the highest point

of the next hilly district, at Hambleton end, twelve hundred and forty-six feet above the sea.

The rocks which compose this moorland district rest upon the red marl and sandstone. In the following table, they are numbered according to the general series of Yorkshire strata, pages 2, 3.

	Greatest observed thickness. Feet.	
Carboniferous and oolitic formation.	6	10 Impure, sometimes oolitic limestone, full of shells. (The *cornbrash* of geologists.)
	200	11 Sandstone, shale, ironstone, and coal, with carbonized wood, ferns, and other fossil plants.
	30	12 Impure, often oolitic limestone, and ironstone, with many fossil shells. (*Oolite* of Lincolnshire.)
	500	13 Sandstone, shale, and coal, with carbonized fossil plants.
	60	14 Subcalcareous, irony sandstone, often containing shells, called *dogger*. (*Inferior oolite and sand* of Somersetshire.)
Lias formation.	200	15 Upper lias shale, or alum shale, with nodules of argillaceous limestone, ammonites, belemnites, &c. (*Blue marl* of Northamptonshire.)
	150	16 Ironstone and sandstone strata, with terebratulæ, pectines, cardia, aviculæ. &c. (*Marlstone* of Northamptonshire, &c.)
	500	17 Lower lias shale, with gryphææ, pinnæ, plagiostomæ, &c. (*Lias shale* of Somersetshire.)

THE LIAS FORMATION.—The lias formation first appears on the sea-coast, under the High Peak, near Robin Hood's Bay, and continues along the shore, with only one exception west of Whitby, to Saltburn and Redcar; being very generally covered, in all the higher cliffs, by the lower portions of the carboniferous formation. Its great thickness is apparent in the sides of Robin Hood's Bay, and in the precipices of Rockcliff. Inland, it follows the sinuosities of the moorlands above Guisborough, by Rosebury Topping, Burton Head, and Carlton Bank, towards Hambleton, and extends a considerable space into the low plains lying to the west of those hills. It is exposed by denudation along a great part of the valley of the Esk, and in many of its tributary branches,

as well as in the deep hollows of Bilsdale, Bransdale, Farndale, and Rosedale, and appears to be the general base of all these elevated moorlands. Its utmost thickness is not visible on the sea-coast, though in Rockcliff, and on the sides of Robin Hood's Bay, nearly six hundred feet are exposed. At the head of Bilsdale, the upper edge of the lias is eight hundred feet above the plain below, and one thousand feet above the town of Stokesley, which is on the same formation. In Rosebury Topping, the upper edge is one thousand feet above the lower beds of it at Redcar. Where the moorlands slope beneath the second hilly district, at Hambleton, the lias descends and spreads in the low ground about Thirsk, Easingwold, and Sheriff-Hutton. It crosses the Derwent at Howsham, and proceeds by Leppington and Bugthorpe, till it comes to be almost concealed under the chalk-hills at Garraby and Bishop Wilton Its course, however, is still continued in a narrow tract, beneath the chalk, by Millington and Londesborough to Market Weighton; after which it turns out from the wolds, and proceeds by Northcliff and North Cave, to the Humber at Brough ferry. Beyond this river, its range is uninterrupted through Lincolnshire and the midland counties, to Bath and Lyme-Regis.

The upper edge of the lias is so distinctly marked below the carboniferous sandstones which cover it, that by means of many barometrical observations I am enabled to state, pretty distinctly, the average amount of its declination in several directions. It appears at a greater altitude along the breast of the hills south of Stokesley than in any other part with which I am acquainted. Under Wainstones cliff it was found to be nearly twelve hundred feet above the sea. At Brandsby, which is in a line due south, and distant nineteen miles, it is about two hundred and eighty feet above the sea; the difference of level is equivalent to nearly fifty feet per mile. From the same point at Wainstones, the lias sinks in an easterly direction to the level of the sea under the High Peak, at a distance of twenty-eight miles; this is at the rate of nearly forty-three feet per mile. From the same point, the dip to the top of the lias on the south side of Whitby harbour, in a direction E. by N., is fifty-five feet per mile. The general declination of strata, in

the district S. of the Esk, is towards the S. E. On the north side of that river, the upper plane of the lias is nearly one thousand feet high in Rosebury Topping. From hence to the Lyth alum works, distant seventeen miles and a half, in a direction almost due E., the dip is eight hundred feet, or about forty-five feet per mile: to Rockcliff, E. N. E., twelve miles, the dip is forty-six feet per mile, to Eston Nab N., four miles, eighty feet per mile. Hence it may be inferred that on the north side of the Esk river, the strata generally dip to the N. E.

The above measures were taken in directions where the results are very little affected by dislocations. But local variations of dip are very numerous. From Huntcliff and Rockcliff, the strata sink both toward the east and the west; between Whitby and Bay Town they form a basin with meeting slopes; and in Robin Hood's Bay they turn up in what is called a saddle. The most remarkable of these dislocations are under the High Peak and west of Whitby. (Consult the section at all these points.) The three members of the lias formation may be seen on the sea-coast in juxta-position at Robin Hood's Bay, and in the high cliffs of Boulby and Rockcliff. The upper and lower shales are seldom so well exposed, as to admit of being studied with advantage inland: but the middle group may be examined in Eston Nab, in Eskdale, along the front of the Cleveland Hills, in Bilsdale, and in the neighbourhood of Easingwold; and in all these places its characteristic position in the shale, and the abundance and peculiarity of its imbedded fossils, eminently distinguish it, and strongly remind the geologist of the "marlstone" of Lincolnshire and Northamptonshire, to which it is certainly to be referred.

The carboniferous and oolitic formation.—This formation is found resting upon the lias in all the high hills and cliffs which belong to the moorland district. As its character is, in a considerable degree, peculiar, it may be well to introduce here an epitome of its general history, for the sake of comparing it with the oolitic strata of the midland counties, and the carboniferous series of rocks at Brora, in Sutherland.

THE DOGGER SERIES, (No. 14,) which immediately covers the lias, is a group of sandstone rocks very variable in appearance and composition. Where fully developed, as on the sea-coast at Blue Wick, under the High Peak, it presents a considerable thickness of subcalcareous irony sandstone, with several layers of shells and pebbles, of which the lower part assimilates very decidedly to the lias beneath. In consequence of this assimilation, we may conclude* that both formations are here complete, In the sea cliffs farther west, the dogger series is not known to contain any shells, nor does it generally exhibit any such gradation in character to the lias beneath. Some parts of the stratum, therefore, are in such cases, wanting. Shells of the same kinds are those which fill the dogger at Blue Wick, are again found in it at the fine cascade, a few miles from Whitby, called Falling-force; in the upper part of Goadland Dale, and at Coldmoor, and other places in the Cleveland hills.† Commonly about Whitby and Robin Hood's Bay, its lower layers contain nodular masses and fragments of ironstone, argillaceous limestone, red clay, porphyry, white felspar, vitreous quartz, and blende; but in the cliffs which range far to the west, the dogger is distinguished only by its very irony composition, and largely nodular structure. In some places it is even but little distinguishable from common sandstone, or is deficient altogether. Its utmost thickness is about sixty feet.

In consequence of its own characters, its position upon the lias, and its evident assimilation to the upper lias shale, I think it may be concluded that the conchiferous dogger beds at Blue Wick are the representatives in Yorkshire of the inferior oolite and sand of Somersetshire. What light the fossils contribute to this inquiry, will be seen hereafter.

The SANDSTONES and shale, with fossil plants and coal, (No. 13,) which succeed and cover the conchiferous series just described, occupy

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* See Professor Sedgwick's remarks on this subject, Ann. Phil. May, 1826.

† I take this occasion of expressing my thanks to the Rev. L. V. Vernon, for the valuable information he has afforded me on the geology of the Cleveland hills.

the lower and middle parts of the cliff from Cloughton Wyke to the High Peak. They appear on all the higher parts of the coast, from Robin Hood's Bay to Huntcliff; and thence, retiring inland, cap all the high Cleveland hills before mentioned. The lowest part of this series of rocks usually contains a considerable portion of shale, and some thin layers of white and yellow sandstone, with fossil plants and irregular seams of bad coal. Occasionally, this part swells out to a great thickness, and encloses two very distinct layers of fossil plants: those which lie nearest to the dogger consist of cycadiform fronds and ferns of different kinds, and are imbedded in white carbonaceous sandstone and shale, or in ironstone. The upper layer consists of only one kind of equisetiform plants, standing vertically, as if in the attitude of growth, in a bed of sandstone, which rests on shale. A considerable thickness of sandstones and shales covers these plants at High Whitby and in Stainton-dale cliffs; and further south towards Cloughton Wyke, still higher repetitions of the same kind enclose a thin seam of coal, which is there worked, as well as at Maybecks and other places on the moors. This coal seam occurs nearly at the top of the sandstone series, which has been thus shewn to enclose two distinct, though irregular, layers of coal, and at least two deposits of fossil plants, but no fossil shells.

THE CALCAREOUS STRATA, (No. 12,) now to be noticed, which lie in the midst of the carboniferous sandstones, are of small agricultural value, but of great geological importance. For, in conjunction with the dogger series, they afford a very ample suite of organic fossils, fully demonstrating the relation of these two strata to the oolite formation of Lincoln and Bath, with which they are actually connected by intermediate points. This limestone is seen in the extensive low-water scars between Gristhorpe and Redcliff, at the northern point of Cayton Bay, and along the shore at low-water, from White Nab to near the Spa at Scarborough. From this point it is below the level of the sea, till we approach Cloughton Wyke; beyond which it rises along the high cliffs of Haiburn and Stainton-dale, to near the Peak house. Hence it recedes inland, encircles the vallies which descend to Robin Hood's Bay, and passes by Hawsker, to Maybecks on the Sneaton moors. It occurs again in Commondale,

one of the branches of Eskdale, and, after passing by an obscure course across the moors, reaches Hood hill, Coxwold, and Owlston. It now becomes decidedly oolitic in the lower part, and slaty in the upper part; and these distinct portions of the rock, separated by sandstone and a layer of pale blue clay, range by Brandsby, Terrington, and Crambe, to the quarries about Westow, and are continued more obscurely between Leppington and Acklam, to Kirby Underdale, where they pass under the chalk hills. The oolitic part of the group re-appears from beneath the wolds at Sancton, and ranges by Newbald, Everthorpe, Ellerker, and Elloughton, to the Humber, near Brough ferry. The Lincolnshire oolite, beyond this river, is a continuation of the same rocks increased in thickness.

On the sea-coast, and in the eastern moorlands, these calcareous strata are much debased by admixture of sand, argillaceous matter, and ironstone, so as to be very indifferent limestone, and very unlike the usual appearance of oolite. But in the western part of the same district their aspect changes; the rock becomes more united in itself, and more separated from the sandstones about it, and assumes its true character of oolite. The upper fissile portion, at Brandsby and Terrington, appears to agree remarkably in structure, composition, and organic remains, with the slaty stone of Wittering heath and Collyweston in Northamptonshire, and Stonsfield near Oxford, which was referred by Professor Buckland, and geologists generally, to the forest marble. Mr. Lonsdale's recent researches have, however, proved it to belong to the lower portion of the Bath oolite. This slaty stone seldom occurs in a satisfactory manner on the sea-coast, and yet is not entirely deficient: it may be examined at the northern extremity of the point called White Nab, near Scarborough.

The sandstones and shales, (No. 11,) now to be noticed, which rest upon the oolitic limestone, have a general resemblance to those which cover the dogger. The lower part consists chiefly of thick, irregular strata of sandstone, often interspersed with nodules of ironstone and layers of shale, containing small and very confined seams of coal, and local deposits of fossil plants. Above, is a thick deposit of dark and light-coloured shale, with alternations of thin standstones.

The plants which lie in the shale and ironstone, belong to the same tribes of cycadeæ, ferns, and lycopodiform plants, as those which were mentioned in the lower carboniferous sandstones; but the species are generally distinct. The sandstone is often filled with fragments of carbonized wood, like so many pebbles; and, occasionally, it contains large carbonized branches. Its surfaces are generally black, with particles of the same substance. This series may be observed upon the coast, from Gristhorpe Bay to near Scarborough, and from that town northward to Cloughton Wyke; and its lower sandstones appear along the top of some of the high cliffs between Haiburn Wyke and the Peak. Its course inland is on the north side of the tabular hills which range from Scarborough to Hambleton; but is not very easily defined across so wild a surface of heath and bog. It is probably thickest, and certainly is best known, in the vicinity of Scarborough.

The calcareous bed (No. 10,) which is found at the top of this carboniferous formation, has a considerable resemblance to the calcareous layers which have been already described; but its position under the Kelloways rock, and the general character of its organic fossils, justifies Mr. Smith's opinion, that it is referrible to the "cornbrash" limestone of the southern counties. It is a thin, fissile, partially oolitic stone, remarkably filled with terebratulæ, trigoniæ, unioniform shells, and small clypei. Gristhorpe Bay, and Redcliff, and the vicinity of Scarborough, are the only points where I have seen it distinctly exposed; and great difficulties must always attend the efforts to trace so thin a rock across the interior of the country; I have examined it in Newton dale, but it has not yet been discovered on the western side of the moorlands.

Having thus noticed, in general terms, the characters of the carboniferous and oolitic formation, it remains to state, that of this whole series, which measures, in some places, not less than seven hundred feet in thickness, no part whatever is continued across the Humber, except the calcareous strata. Indeed, I am in doubt whether any portion of the sandstones, shales, and coal, is prolonged to the south so far as the river

Derwent. No such strata are known among the oolites, in any other part of England: very similar rocks occur, however, at Brora in Sutherland; and M. A. Brongniart has described some of their characteristic plants from Scania.

If we were to put out of consideration the shelly beds of limestone, which alternate with them, we should find in these carboniferous rocks, much resemblance to that more ancient deposit of coal, and sandstone, and shale, which has been expressly called the coal formation. But still we are furnished with the most satisfactory means of discrimination, in the plants which accompany the coal: for though, perhaps, one hundred species of fossil plants have been discovered in the west-riding coal-field, and not less than fifty in the sandstones and shales of the north-eastern coast; it is not too bold an assertion to affirm, that no one species has yet been found which is common to both situations.

THE TABULAR OOLITIC HILLS.

These hills meet the sea-coast between Filey and Scarborough on the east. They rise toward the north from under the vale of Pickering, and terminate in a remarkable line of escarpments at Silpho Brow, Blakehoe Topping, Saltergate, Lestingham, Easterside, and Black Hambleton. From the vale of Pickering the ascent to them is long and gradual, but from the northern moors it is very short and abrupt. The altitude of the hills increases westward. Thus, Gristhorpe cliffs are about two hundred and seventy feet high; Oliver's mount, four hundred and ninety feet; the heights above Troutbeck, six hundred and fifty feet; above Rievaulx Abbey, eight hundred feet; and at Hambleton, twelve hundred and forty-six feet. Even at considerable distances, the plane summits and abrupt terminations of these oolitic hills are very remarkable.

From Hambleton, this range proceeds southward by Wass bank, nine hundred feet, and eastward by Ampleforth and Oswaldkirk bank, three

hundred and thirty feet, to Stonegrave, beyond which place it sinks beneath the vale of Pickering. A branch of this range, separated from Oswaldkirk bank by the valley of Gilling, extends in a south-easterly direction to Malton, where it crosses the Derwent, and, after rising into the high ground of Langton wolds, turns again to the south, and passes under the chalk-hills at Acklam. Some of the strata which belong to this group of rocks, re-appear from below the chalk in the neighbourhood of South Cave, and are continued in Lincolnshire. The surface occupied by this district is about one hundred and ninety square miles: it includes the following strata:

Coralline oolite formation.	Summits and edges of the tabular hills.	5 Upper calcareous grit, containing fossils resembling those in No. 7.
		6 Coralline oolite, marked by corals, echini, plagiostomæ, melaniæ, &c.
		7 Lower calcareous grit; pinnæ, gryphææ, ammonites, &c.
	Slopes of the same hills.	8 Gray argillaceous earth, containing many fossils at the bottom. (Oxford clay of the south.)
		9 Ferruginous or argillaceous sandstone, with remarkable gryphææ, ammonites, &c. (Kelloways rock of the south.)

Of the strata here enumerated, possibly all may be equally extensive, but some are more easily traced than others. The Kelloways rock, often thirty feet thick, shews itself on the coast at Gristhorpe and Scarborough, and in several points inland along the northern escarpment of the tabular hills; it also appears on the eastern side of the Derwent, and in the neighbourhood of Cave. Every where, characteristic fossils accompany it, and establish the agreement between this rock and that so named in Wiltshire, which had been already inferred from geological position. The argillaceous stratum, which separates the Kelloways rock from the lower calcareous grit, represents in Yorkshire the clunch clay, or Oxford clay of the southern counties. It continues along the breast of the great escarpment of the tabular hills from Scarborough towards Hambleton and Wass bank, and is less distinctly traceable where the same range turns eastward, by Ampleforth and Castle Howard, but has not yet been

found about Cave. The lower calcareous grit and coralline oolite are extremely well connected from Scarborough round the vale of Pickering to Acklam, but they have not been seen further south. The calcareous rocks which range close under the wolds of Lincolnshire do not belong to this formation, as I have lately had the means of ascertaining. The upper calcareous grit covers the coralline oolite at Stonegrave, Oswaldkirk, Ampleforth, and Wass bank, and, in lower ground, at Helmsley, Kirkdale, and Sinnington *. It also occurs, as Mr. Smith informs me, in the same manner on Silpho Brow, near Scarborough.

That all the strata of the tabular hills should be included in one formation, appears to me satisfactorily demonstrated by the gradations they present between each other. Thus the Kelloways rock changes into the Oxford clay, which is still more evidently blended with the lower part of the calcareous grit. The calcareous grit and coralline oolite above are so harmonized at their junction, that it is not easy to mark the exact line; and the similarity of character between the upper and lower beds of calcareous grit completes the evidence which warrants the combination of all these strata into one natural group.

Whoever compares this series of strata with the coralline oolite formation in Berkshire and Wiltshire, will find them extremely similar in the mode of arrangement, in mineralogical composition, and organic contents. The features which they impart to the country are much alike in both districts, and the whole evidence in favour of their affinity is complete and satisfactory. Yet the two districts lie wide asunder, and in all the intermediate tract a great portion of the series is unknown. From Acklam to the neighbourhood of Oxford, no coralline oolite or calcareous grit appears at the surface, (the limestone before mentioned in Lincolnshire, is of more recent formation,) and the Kelloways rock has not yet been described between Huntingdonshire and the Humber. This should teach us not to undervalue the evidence of organic remains, for these are always useful and often necessary guides to determine the

* See Phil. Mag. and Annals of Philosophy, April, 1828.

affinities of detached portions of the strata; and, when viewed in combination with the substance and arrangement of the rocks, the results to which they lead may be confidently adopted.

THE VALE OF PICKERING.

THIS valley, or rather wide level, containing nearly one hundred and sixty square miles of surface, lies between the parallel ranges of chalk and oolite. Its eastern portion, contracted by the nearer approach of these high ridges, is prolonged to the edge of the sea cliffs about Filey; on the west, its waters pass, by a narrow valley of denudation, through the oolitic hills which extend from Castle Howard to Malton and Langton wold. Were this narrow passage closed, a large portion of the vale of Pickering would become a lake, discharging itself into the sea near Filey, through cliffs about seventy feet high. Professor Buckland, in his admirable work, the 'Reliquiæ Diluvianæ,' seems to admit the probability of the vale of Pickering having been an antediluvian lake, which was drained when the present outlet at Malton was effected.

The idea of its having been a lake naturally offers itself to every one who considers its wide level surface, and remarks the multitude of streams which run into it, and pass out by the single channel of the Derwent. But I do not think that the *present* appearances of the vale can fairly be employed to support opinions as to its condition before the flood. The vale of Pickering has a partial surface of alluvial sediment, and a general covering of diluvial clay and pebbles, upon a substratum of blue clay. How vast a load of diluvium lies on this stratum, in particular situations, is known to those who have inspected the cliffs between Speeton and Filey; and similar accumulations prevent it from appearing in all the central part of the vale. The present flat appearance of this great hollow, therefore, is owing to the effects of diluvial and alluvial agencies; and affords no clue to its antediluvian

condition. The upper portion of the blue clay which is believed to underlie the whole vale of Pickering, shews itself beneath the chalk wolds at Speeton and Knapton, and at each place produces fossils much resembling those of the "gault" of Kent and Sussex. The lower blue clay appears along the north side of the vale of Pickering about Kirby-Moorside and Helmsley, as well as at Settrington and North Grimston, near Malton, and at Elloughton, near Cave; and at several of these points it yields the ostrea deltoïdea, which is one of the most characteristic shells of the Kimmeridge clay.

THE CHALK WOLDS.

THE wolds of Yorkshire form one of the most remarkable features in this county. High and bare of trees, yet not dreary nor sterile, they are furrowed as all other chalk-hills, by smooth, winding, ramified vallies, without any channel for a stream. Where several of these vallies meet, they produce a very pleasing combination of salient and retiring slopes, which resemble, on a grand scale, the petty concavities and projections in the actual channel of a river. No doubt these vallies were excavated by water, but not by the water of rains, or springs, or rivulets. Some greater flood, in more ancient times, has performed the work, and left the traces of its distant origin in the pebbles which it has deposited along its course.

From the Humber at Hessle, the high wolds range in a north-western direction to Riplingham Clump and Hunsley Beacon, five hundred and thirty-one feet high; and, passing above Market-Weighton, reach their greatest elevation near Garraby Beacon, eight hundred and five feet above the sea. Hence, their edge continues by Wharram and Settrington, and, turning to the east, skirts the vale of Pickering, and fronts the sea in a long range of lofty cliffs from Speeton to Flamborough head. From this elevated line the surface slopes eastward to Cottingham, Beverley, and Driffield, and southward to Burton-Agnes and Bridling-

ton; and, at all these places, the chalk sinks below the wide diluvial and alluvial plains of Holderness. The extent of surface occupied by the chalk formation of the wolds is about three hundred and seventy-six square miles, and the thickness of the stratum not less than five hundred feet. Throughout its whole course its mineral characters are much alike; and its fossil remains nearly identical: yet, as the beds are more completely exposed on the sea-coast, it is from Bridlington and Flamborough that most fossils are procured. The rock is generally much harder than in the southern counties, and the layers of flint are more diffused through its substance. On the western slopes of the wolds, as about Bishop-Wilton and Brantingham, the lower portion of the chalk is softer than the upper part, and apparently more argillaceous; it seems to correspond with the chalk marl of Oxfordshire, but no fossils have been collected from it. At the bottom are red layers, containing small belemnites (B. Listeri) and terebratulæ, which do not occur above. The blue clay of Speeton ends abruptly under the chalk, without any traces of gradual change.

In wells and pits sunk on the wolds, the chalk has been several times perforated, and found to rest on Kimmeridge clay, near Sherburn, and on lias, containing characteristic fossils, (of which specimens have been presented to the Yorkshire Philosophical Society by the Rev. T. Rankin,) at Huggate. The latter fact is highly important, as it shews to what an extent the unconformed arrangement prevails under the central part of the wolds.

HOLDERNESS.

Holderness, taken as a natural division, may be said to include the whole country lying between the eastern slope of the Yorkshire wolds, the German ocean, and the channel of the Humber. Its western limit passes by Bridlington, Burton-Agnes, Driffield, Beswick, Beverley, and Cottingham, to Hessle; what may have been anciently its extent towards the east and south-east, is not easily determined, because

on these sides it is exposed to a turbulent sea, which its loose materials are ill calculated to resist. Its greatest length is somewhat less than forty miles, and its extreme breadth about sixteen. It includes about three hundred and eighty square miles of surface, of which, perhaps, seventy square miles are marshland, relinquished by the sea, according to a regular process of nature, or reclaimed by the enterprising industry of man. The remainder of the surface, though, on a general view from the wold-hills above, it appears like one extended plain, is found, on closer inspection, to be remarkably undulated; and though no land in the whole district exceeds one hundred and forty feet in height, yet, as the valleys are often sunk to the level of the sea, the hills assume a degree of importance which a stranger would by no means expect.

The long straight line of its coast, which is so remarkable a feature in the topography of Holderness, furnishes the most advantageous opportunity of examining its geological structure; for these cliffs, daily wasted by the sea, exhibit distinct sections of nearly all the materials that exist in the country. The drains which intersect the marshland, and the wells which have been found necessary in a country having few natural springs, complete the facilities for its investigation.

There is, perhaps, hardly any district in the island, which displays in so striking a light the powerful effects of diluvial torrents as Holderness; for in this country accumulations, from this cause, compose the whole mass of every hill, and form the deep foundation of every marsh. In the cliffs of the coast and in the gravel-pits of the interior, remains of antediluvian animals are frequently met with, and the interest which these discoveries cannot fail to excite is increased by the abundance of the alluvial deposits which have happened in the same country at various subsequent periods, and contain the bones of animals of a more recent date. The remains of creatures overwhelmed by the flood, and of those which perished after it, lie here not far asunder, ; the circumstances attending their destruction may be deliberately examined, and the contemplative mind is presented with a physical record of the principal changes to which the surface of the earth has been exposed, from those early periods to the present day.

Throughout the eastern parts of Yorkshire the detritus left by these remarkable floods has so much of a common character, and such relations to the existing and extinct races of land animals, as to mark *in this country* a definite geological æra, which in the following descriptions may be conveniently referred to as the diluvian or clysmic æra. The previous period from a like consideration will be sometimes called antediluvial. The floods themselves might with propriety be styled a 'Deluge,' but for the danger of confounding by this term, the Noachian or Historical Catastrophe, with a geological event, whose date may be wholly different.

Diluvium.—Wherever in Holderness the earth has been penetrated to a sufficient depth, diluvial accumulations have been found at the bottom. However deep, in some instances, are the deposits of clay and peat in the sites of ancient lakes, and of silt in places overflowed by the tide, all these deposits rest on a basis of diluvial clay or gravel. I mention this general truth thus early, because some confusion has existed concerning it, and, in consequence, a great mistake has been committed with respect to the antiquity of the deposits of peat and timber. Thus, in the Philosophical Magazine for April, 1827, Mr. R. Taylor, comparing the subterranean forest, as it is called, of the Yorkshire coast to that of East Norfolk, is led to suppose that both these accumulations of timber, with all their imbedded bones, took place before the dispersion of the diluvial detritus. I do not presume to say any thing concerning the forest of East Norfolk, but, on what I think very sufficient evidence, I venture at once to affirm that the subterranean forests of East Yorkshire grew since the diluvian era. Of this satisfactory proofs will be adduced, when I come to describe particularly the appearances on the coast: it may, therefore, be sufficient now to state, that in several places the timber, peat, shells, and sediment, which together make up the lacustrine deposit, are seen resting on a depressed part of the diluvial clay and gravel. For the very same reason, then, that the diluvial accumulations are admitted to be posterior to the rocks which they cover, we must allow that the subterranean peat and timber are of still later date.

The lowest of all the accumulations which rest upon the chalk of the wolds is an irregular layer of fragments of chalk and flint, which, being derived from the stratum beneath, are very little water-worn. This singular deposit seems due to a less violent action of running water than the general mass of heterogeneous pebbles which covers it. It seems to indicate that the effects ascribed to a deluge, were of different kinds, and produced at different periods; as if the water had been liable to great periodical or successive commotion. I am not aware that any remains of land animals have occurred in this rubbly deposit, near Flamborough, or on the wolds; but at Hessle it contains the teeth and bones of the extremities, of horse, ox, and deer, very little worn by attrition. These bones, therefore, belonged to animals residing in the neighbourhood; and as they are now covered up by a great thickness of clay and pebbles, derived from a far greater distance, we cannot doubt their antediluvian origin. I think the rubbly layer of chalk and flint fragments is not found on the highest parts of the wold-hills, but has been drifted chiefly to the lower part of their slopes.

The thickest and most extensive of the diluvial accumulations in Holderness is a mass of clay and pebbles. In the cliffs north of Bridlington and at Hessle, it is seen to cover immediately the water-moved rubbly chalk and flint, which lie on the great stratum of chalk. It extends in a connected mass, under nearly all Holderness, forming most of the hills and "hard land," and underlying most of the accumulations of gravel and alluvial sediment. In the highest cliffs on this coast, its thickness is not less than one hundred and thirty feet. Its composition is remarkably uniform. We every where observe it to be a solid body of clay, containing fragments of many kinds of rocks, which vary in magnitude, and in the degree of roundness to which they have been reduced. The fragments are, in general, not so numerous as to touch each other, but are scattered through the clay as plumbs in a pudding. However, on the top, or in the uppermost part of the deposit, they are sometimes aggregated into distinct layers of gravel, which continue for a short distance, and furnish springs of good water. The rocks from which the fragments appear to have been trans-

ported are found, some in Norway, in the highlands of Scotland, and in the mountains of Cumberland; others in the north-western and western parts of Yorkshire, and no inconsiderable portion appears to have come from the sea-coast of Durham, and the neighbourhood of Whitby. In proportion to the distance which they have travelled, is the degree of roundness which they have acquired. All the fragments of granite, porphyry, mica slate, and clay slate, which can be compared with no fixed rocks nearer than those of Cumberland and Westmoreland, are rolled to pebbles; the angles are worn away from every mass of limestone which has been drifted from the north-western hills of Yorkshire; but those which have been brought from the nearer points of the chalk range have yielded much less to attrition. Some attention is required to the original hardness of the stones: we find solid masses of ironstone and quartz much less worn than granite; limestone is less rounded than millstone grit; and flint retains uninjured angles, whilst chalk and magnesian limestone have lost their original surfaces.

Few substances originally soft are carried by water to a great distance, in a solid form. The sandstones of the western and north-western parts of Yorkshire, are plentiful in the gravel of the vale of York; but only the hard "galliard" of Leeds and Bradford, and the solid millstone grit of the moors, can be recognised in the clay of Holderness. This clay is itself, no doubt, an aggregate principally of the particles into which the softer strata exposed to the ravages of water, have been resolved. Its vast bulk need not surprise us, when we remember the distance traversed by the currents, and consider how large a portion of the mass removed was clay and disintegrated sand. We might have expected to find these finer particles at the top, and the solid fragments of rocks lying beneath, according to their individual magnitude and weight. As nothing of this kind is observable, we must suppose the flood to have moved with such extraordinary violence, that its spoils, when heaped together, were little influenced in their arrangement by the direct force of gravitation.

The ancient organic remains which lie scattered in this clay, must be considered in two very distinct groups: those which were removed

from rocks in which they had been previously deposited; and those which belonged to animals then existing on the earth, or in the sea. To the former class appertain lithophytous corals from the mountain limestone, fossil plants from the coal series, ammonites, belemnites, pectines, and many other shells from the lias; and belemnites, echini, and inocerami, from the chalk. These remains furnish very important evidence towards determining the direction of diluvial currents.

But the other class of remains, the bones of animals which were in existence in these regions during the diluvial period, and the shells which, during the agitation, were dragged up from the deep, and mixed with the general spoils of the land, lead us to still more interesting conclusions. For when among hard stones which have been worn to pebbles, we find the tusks, teeth, and bones of antediluvian quadrupeds comparatively uninjured, retaining their characteristic shape and often their original surface, we must surely be convinced, that such remains have not been removed far from the places where the animals lived. The only reliquiæ of this kind, which I have been able to assure myself were found in this clay, are those of the mammoth, (elephas primigenus.) Teeth and tusks of this animal have been collected in many places on the sea-coast, and I once found a small fragment of a tusk at Hessle. This deposit of clay is not confined to the flat district of Holderness, but is found in some of the valleys of the wolds, thus indicating the extent of the diluvial action, and determining the minimum of antiquity of these valleys.

It was observed that, occasionally, patches of gravel and sand were found lying enclosed in the great deposit of clay. Such are seen in many places on the sea-coast, particularly near Dimlington, near Skipsea, and toward Bridlington. In several places, inland, these accumulations are much more considerable, and compose hills of a remarkable appearance, as at Brandesburton, and in the neighbourhood of Paghill and Keyingham. An elephant's tusk has been found at Brandesburton, and in the neighbourhood of the latter places I have observed abundance of antediluvian marine shells, intermixed with the gravel. As this

occurrence is seldom witnessed, it may be proper to give the results of a careful examination of the attendant circumstances.

Some vague reports concerning these shells induced Mr. Smith to consider them as indications of the crag formation, and he expressed this opinion on his map of Yorkshire, (1821.) In 1824, I saw specimens collected by Mr. Smith and Mr. Salmond, from a situation which will be described; and was immediately convinced that they were not specifically distinct from shells now existing in our own seas, and, therefore, felt unwilling to believe that they were of such great antiquity. This opinion was proved correct by an examination of the locality in 1828. About a mile south of the house of my kind friend, Mr. Stickney of Ridgemont, near Hedon, is a large excavation, from which gravel has been obtained for the neighbouring roads. The highest point of the hill in which the excavation is made, is thirty-six feet above the adjacent marshland, which Mr. S. informs me is five feet below the level of high water at spring tide, and the pit is sunk down to the level of the marshes. Sand, pebbles, and marine shells of comparatively recent, and water-worn fossils of more ancient date, are here mixed together, in confused and irregular layers. The pebbles and fossils may be clearly identified with the chalk and flint of the wolds, the lias and oolite of the coast near Whitby, the magnesian limestone near Sunderland, the coal and limestone series of western Yorkshire, as well as the grauwacke and other slate rocks, with porphyry, granite, &c. of Cumberland and Westmoreland.

Amidst this heterogeneous mass, which indicates such various and violent currents of water, it is remarkable that we find many rather delicate marine shells, in tolerable perfection. Besides the strong shells of Turbo littoreus, Purpura lapillus, and Buccinum undatum, we have Mya arenaria, Tellina solidula and tenuis, Mactra subtruncata? Cardium edule, * and a shell which in an imperfect state appeared to be Crassina

* It must be owned the gravel shells are generally less truncate posteriorly, and less convex than the recent specimens; but there are variations in the form of Cardium edule, some individuals being more oblique than others: both varieties occur in this gravel-pit.

scotica, but is certainly of a different genus. The shells are most abundant along particular layers in the gravel. The mass descends to a great depth, and is found beneath the adjacent marshland, which consists of fine clay, lying upon peat and trees, and is part of an extended level tract, reaching from the Humber near Pattrington, almost to the sea, at Sandley mere. It seems to have been, at some former period, a channel for some vast volume of water; for it winds as other vallies do, and the gravel hills which bound it are abrupt on the concave side, and slope gently down on the other.

In the cliffs against the Humber at Paul, very similar phenomena are observed. The gravel and sand are here remarkably contorted, and intermixed with alternating layers of a sediment much like warp. The shells are of the same kinds as in the pit near Ridgemont, in similar disorder, and equally plentiful. The pebbles and fossils, mixed with them, are also very similar, but the masses are generally very small, and flint is more abundant, a circumstance probably depending on the proximity of the chalk wolds.

As these are the only examples of recent marine shells mixed with diluvial detritus which have fallen under my examination, I hardly presume to offer any conjectures as to the peculiar conditions of the waters which heaped them together. Repeated investigations of the tracts over which fragmented rocks were dispersed from their original sites, have convinced me that many local eddies and minor currents interfered with the great diluvial streams, and often caused an accumulation in one spot, of materials brought in very different directions. Such an explanation may, I imagine, be applied to the case before us; but until analogous examples shall be adduced, and the history of the crag stratum of Norfolk and Suffolk be more adequately developed, the subject must remain in obscurity.*

* Very interesting and somewhat analogous cases have been since observed by Mr. W. Gilbertson, in the vicinity of Preston, and by Mr. Trimmer on the slope of Snowdon.

Alluvium.—The alterations in the form of land, occasioned by diluvial agency, must have been considerable, but are not yet well understood; the operation of natural causes since that period, deserves to be maturely considered, for these have materially changed the face of the globe. The lakes, which were left on the retiring of the diluvial currents, appear to have been continually diminished in depth, and contracted in extent, by deposits of vegetable matter, decayed shells, and sediment brought into them by land-floods. In this manner many inland lakes have been extinguished in Holderness, and nothing remains to denote their former existence, but the deposits by which they have been filled. It is remarkable that the observers of this coast have bestowed very little attention on the lacustrine deposits which appear so frequently on the cliffs, and exhibit, so convincingly, the proof of long-elapsed time since the date of the fundamental diluvial formation. To amend, in some degree, this defect, I propose to describe them pretty minutely in my observations on the section; but it will be desirable to sketch a general outline of their characters here, and to put them in comparison with the contemporaneous marine deposits, which are so remarkable on the shores of the Humber.

All the lacustrine deposits containing peat, which I have inspected in Holderness, agree in this general fact, that the peat does not rest immediately upon the diluvial formation beneath, but is separated from it by at least one layer of sediment, which is seldom without shells. The peat is very generally confined to a single layer, and shells are seldom found above it. Supposing that all the varieties which I have witnessed in different places existed together, the section would be nearly in the following general terms:

1 Clay, generally of a blue colour, and fine texture.
2 Peat, with various roots, and plants, and, in large deposits, containing abundance of trees, nuts, horns of deer, bones of oxen, &c.
3 Clay, of different colours, with fresh-water limneæ.
4 Peat, as above.
5 Clay, with fresh-water cyclades, &c. and blue phosphate of iron.
6 Shaly curled bituminous clay.
7 Sandy coarse laminated clay, filling hollows in the diluvial formation.

Of these, the most constant beds appear to be Nos. 1, 2, and 5, and, in general, these constitute the whole deposit. In different places, the layers exhibit much diversity of colour, consistence, and thickness. The peat varies in its thickness from five feet to less than as many inches, and its constituent parts seem not the same: in a few instances there are no shells in the lower clay, and when they do occur, they are sometimes of different kinds; cyclades and paludinæ are most plentiful. Anodons occur in it at Owthorne and Skipsea, but I did not find them elsewhere.

The quadrupedal remains which have been found in this lacustrine formation belong principally to deer. Bones of oxen, likewise, occur in it. Of deer, at least three species have been discovered in the peat and clay; the great Irish elk, (C. giganteus,) the red deer, (C. elaphus,) and the fallow deer, (C. dama.) A doubtful skull, (found at Owthorne,) in the possession of the Yorkshire Philosophical Society, has some resemblance to the cranium of the chamois.

The extensive accumulations of peat and trees, along the shores of the Humber and its tributary rivers, happened, probably, at the same period of time as those which have contributed to fill up the ancient lakes of Holderness. This is inferred, with great probability of truth, from the position of the peat with respect to the diluvial clay and pebbles; for, wherever these occur together, the former is invariably uppermost. The opinion of the peat extending under the whole district of Holderness, was probably founded on the very considerable depth at which it is, in some places, buried under sediment deposited by the sea. But this silt, accumulated by the action of the tide, which composes the surface of the level land in Holderness, may be easily distinguished from the more ancient aggregations of clay, sand, and pebbles, which belong to the diluvial formation. No fresh-water shells, nor any such alternations of argillaceous marls as those which lie in the site of former lakes, accompany the peat deposit of the marshlands; but it is covered by a marine deposit of silt and clay, such as now drops from the muddy waters of the Humber. The depth of this covering is, in some instances, not less than thirty feet, and the peat lies below the low-water mark;

under what circumstances it was collected together, it is not easy to conjecture. That, at the time of its aggregation, the sea flowed up the channel of the Humber, appears probable, because the first deposits which cover it are of the same kind as those now dropped by the tide; that its formation happened soon after the diluvial era, may be inferred from the fact that it rests almost immediately upon the diluvial detritus; that some remarkable general agency, probably a great land-flood, was concerned in the production of the phenomena, is evident from the extent of the vegetable accumulation.

The following statement of substances found in sinking a well at the Block-house mill, on the east side of the town of Hull, derived from two accounts communicated at different times by my friends, will shew what are the accompaniments of this remarkable layer of peat in Holderness.

		Feet.		*Feet.*
Alluvial deposit.	Soil	1		32
	Clay	6		
	Silt sand	23		
	Moor or peat, with large trees, &c.	2		

		Feet.	*Inches.*		
Diluvial deposit.	Blue clay	1	6	Mixed with chalk fragments, carbonized wood, &c.	62
	Brown clay	22	6		
	Loamy clay	12	0		
	Quicksand	26	0		
	Chalk				16
				Total depth	110

In Ottringham marsh the layer of peat, one yard thick, was found *forty-one yards* beneath the surface; thirty-six yards of various diluvial matter lay beneath, and the chalk was found at the depth of seventy-eight yards.

These accounts are interesting in another point of view, for, by means of them, we can determine correctly the dip or declination of the chalk.

The nearest situations where this stratum sinks below the marshland, are at Hessle and Cottingham. The distance between Hessle and the Blockhouse mill, in a straight line, is between four and five miles; and as the upper plane of the chalk was found in the latter instance ninety-four feet deep, whilst at the former point it appears at the surface, the dip towards the east is twenty feet per mile. The distance from Hessle to Ottringham marsh is nearly fourteen miles, and the declination two hundred and twenty-four feet, or sixteen feet per mile. If this moderate declination be constant, the chalk rock may be reached by wells in many parts of Holderness; and thus, as in similar districts of Lincolnshire, unfailing supplies of water be obtained.

CHAPTER II.

Strata of the Yorkshire coast. Geological description of the Coast of Yorkshire, from Spurn Point to Redcar: including the heights and stratification of all the Cliffs.

Before entering on a particular description of all the cliffs on the sea-coast of Yorkshire, it seems necessary to give a general explanation of the section which is drawn to represent them: for this is not a hasty sketch, designed merely to give a rude notion of the height and stratification of the cliffs, but carefully constructed from many and repeated measurements. It was originally drawn on a much larger size than it would have been practicable to publish; but it is hoped the scale here adopted will be found at once sufficient and convenient. A mile in length of the coast, allowing for its principal flexures, occupies in the section one inch and a half, and four hundred feet of altitude are represented by one inch. This is quite sufficient to allow of expressing all details necessary to a proper exhibition of the strata, in their relative order and thickness. Wherever the nature of the subject requires it, enlarged drawings are added, with proper marks of reference to their place in the general section. For this purpose, the junctions of rocks have been very carefully studied and copied on the spot, and all their minuter peculiarities recorded. Upwards of fifty such detailed sections have been drawn, but it has not been deemed requisite to engrave so many. Such of them have, therefore, been selected as seemed to be most illustrative; and these, with the accompanying explanations, will, it is hoped, be found sufficient to give an accurate knowledge of the coast. With regard to the colouring, the natural prevailing hues of the strata have been generally imitated; but where two rocks could not be thus well discriminated, the difference of their tints has been necessarily exaggerated. It is a common opinion

that all geological works should be coloured upon one model; but what model shall we follow? No geological *map* can possibly be so filled with colours as to embrace all the minor subdivisions of rocks, which in *local sections* it would be unpardonable to omit. Besides, the colours of rocks vary, and circumstances may make it desirable that sometimes a stratum should be coloured strongly to mark its importance, though at other times it would be better represented by a fainter shade. However, to increase as little as possible the confusion of colours which already exists, I have followed in the colours of the oolitic rocks the works of Mr. Smith, and have preferred, with Mr. Greenough, to leave the chalk white. Where rocks were to be thus represented for the first time, I have used such colours as have not been before appropriated.

The heights of the cliffs are represented above the level of high water at spring tide, because this is, upon the whole, the most convenient line that can be referred to; and though it is too variable to serve for the rigorous determination of altitude by graduated instruments, it will be found accurate enough for geological purposes. The tides rise on this coast about fifteen or eighteen feet, and as they very generally lay up much sand at the foot of the cliffs, and as at this level we commonly find much debris accumulated, it seemed, upon the whole, better, except in a few instances, to confine the colouring to the level of high water. It remains to state that the following description is in every particular original; and was mostly executed on the spot.

SPURN POINT.

THE southernmost part of the coast of Yorkshire, is a low peninsula of gravel and sand, accumulated by the sea and the wind, and laid in its peculiar forms by the united action of currents from the sea and the Humber. The materials which fall from the wasting cliffs between Bridlington and Kilnsea, are sorted by the tide according to their weight and magnitude; the pebbles are strewed upon the shore, beneath the precipice from which they fell; the sand is driven along and accumu-

lated in little bays and recesses; whilst the lighter particles of clay are transported away to the south, making muddy water, and finally enter the great estuary of the Humber, and enrich the level lands under the denomination of warp. The sand and pebbles, which were at first deposited near the place where they fell, are afterwards removed further and further south by the tide, and the cliffs are left exposed to fresh destruction. Thus the whole shore is in motion, every cliff is hastening to its fall, the parishes are contracted, the churches washed away, and not unreasonable fears are entertained that at some time the waters of the ocean and the Humber may join, and the Spurn become an island. At present, however, the isthmus stands firm, and, though composed only of a heap of pebbles and sand, and exposed to two strong currents, may, perhaps, be little changed for ages to come. Such is the efficacy of long equal slopes and a pebbly sand, in repelling the rage of the sea.

Among innumerable pebbles derived from the wasted cliffs of Holderness, which are here thrown up by the sea, we observe diallage rock, and mica slate with garnets, and a great variety of sienites, green-stones, and porphyries, which have been derived from Scotland, and perhaps Norway ; much granite from Shap fell, sienite from Carrock fell, breccia from Kirby Stephen, and other Cumbrian rocks ; limestone and sandstone from the western part of Yorkshire, and lias fossils from the neighbourhood of Whitby.

From Spurn Point to Kilnsea, the shore is very low, and, being composed only of gravel and sand, presents little that requires remark. The ruins of Kilnsea church stand upon a low ruinous cliff, of very peculiar composition. Not a single pebble is to be seen in it, but the whole height is a mass of loam or warp, disposed in regular laminæ, whose parallel surfaces are undulated like the broadest ripple-marks on a level sand. (A) is a sketch to shew the peculiar arrangement of these laminæ, and it must be noticed that, in the sharper curves, the laminæ are separated a little from each other. (*a*)

This deposit has so different an aspect from the usual appearance of diluvium, that it might rather seem the result of some uncommon operations of the sea or violent land-floods; but we shall find further opportunities of examining this question, when we come to mention similar phenomena near Bridlington.

From Kilnsea to where the road goes from the shore to Easington, the coast is an extended beach of pebbles and sand, which opposes a low barrier to the union of the sea and the Humber; but from this point cliffs arise, higher and higher, till they reach Dimlington height, which is the loftiest point in Holderness. The beacon here appears about one hundred and forty-six feet above high water, and the whole cliff is composed of clay, with pebbles scattered through it. Here the wasteful action of the sea is very conspicuous: the sand and pebbles being removed from the base of the cliffs by the southward set of the tide, vast masses are undermined, and fall in wild and ruinous heaps; these, as they gradually reach the base, are washed away, and the process of destruction is repeated.

From Dimlington height the cliffs descend to Out-Newton, where they are about thirty feet high. In this part we remark a good deal of gravel deposited in layers, chiefly above, but sometimes in the midst of the clay. The most remarkable appearance of this kind is represented in the sketch (B). Here, near the surface, is a mass of sand and small gravel, five feet thick, in irregular layers, resting upon a bed of coarse gravel, four feet thick; below this comes a layer, four feet thick, of sand and small gravel, in highly-inclined layers; still lower, a repetition of the coarse gravel, five feet thick, and a third series of obliquely-laminated sand, the whole resting upon the blue pebbly clay, the lowest diluvial deposit in Holderness. Near this place, (further north,) we may observe a quantity of gravel in irregular layers, poured, as it were, into a cavity in the pebbly clay.

Between Out-Newton and Holympton, we are surprised by the appearance of a fresh-water deposit of marly clay, on the top of the cliff, about twenty feet above high water. As many of these interesting

deposits will claim our attention, I shall be obliged to restrict my description to those which exhibit the most important characters, and to barely notice those of minor interest. We shall, therefore, proceed about half-a-mile further, to about opposite Holympton, where the cliffs are lower, and a more extended lacustrine deposit appears in a hollow of the diluvium. (See enlarged section, E.) The length of this deposit is about two hundred yards, and its extreme height above the sea about ten feet. It rests in a hollow of the pebbly clay, which abounds along the shore, and consists, under the thin brown soil, of seven distinct layers of clay, the lowest of which contains cyclades and paludina tentaculata, and the lowest but one roots of plants, but no peat. The layers are thus arranged:

Lacustrine deposit.—Brown soil. Bluish bed of argillaceous marl. Shaly clay, changing upwards to white clay marl. Shaly bed of clay. Blue and brown clay marl. Black marl, with plant roots. Grey marl, with cyclades and paludinæ, which inhabited the lake. *Diluvial* clay, with pebbles of quartz, slate, and greenstone.

Beyond Holympton, the cliff, though still low, rises a little toward Owthorne, and displays, in little hollows, two other deposits of laminated clay, indicating the sites of ancient lakes. Of these, the southern is twelve yards across, the other, near Withernsea, one hundred yards.

Between Withernsea and Owthorne, the pebbly clay sinks very low, even beneath low-water mark, and the shore is maintained by the broken edges of a remarkable lacustrine formation. The mere or lake, under whose waters, in ancient times, the clay beds and accumulations of peat and trees were here laid in a regular series, is still represented by a little reedy flat, partly covered by drifted sand. It has been conjectured that this little flat is a continuation of the winding level in which the Winestead drain is excavated, and that in this direction the sea once joined the Humber. But it appears to me that this ancient lake was never connected with the Winestead level, but poured its waters into the sea, under the protection of cliffs which are no longer in existence. The sea line, at low-water, now crosses the middle of the ancient lake, and washes the deposits which happened within it. At the bottom, immediately upon

the pebbly diluvial clay, we find some blue lacustrine clay, containing small specimens of Anodon anatinus; above this, lies a vast quantity of peaty matter, full of hazel nuts and branches of trees; more rarely the bones of terrestrial animals occur, especially of the stag. Specimens of these interesting remains have been presented to the Museum of the Yorkshire Philosophical Society, by the Rev. C. Sykes, Mr. Salmond, and Mr. Backhouse. This deposit ends towards the north, near the little projecting cliff which is all that remains of the church-yard of Owthorne; the church having been some time washed away, and the church-yard so rapidly wasted that all the gravestones have been removed. The buried bones of former generations, which are seen projecting from the crumbling cliff, have a singular appearance, and, combined with the falling of the cliff and the roar of the destroying waves, fill the contemplative mind with solemn and awful reflections. Between Owthorne and Sandley mere, the cliff attains an elevation of thirty-five feet, and is composed of brown and blue clay, with pebbles scattered through it. Two hundred yards south of Sandley mere, is a layer of gravel in the clay, which produces a copious spring. (F.) Wells sunk in the diluvial tracts of Holderness, seldom fail to produce water when they touch a bed of gravel.

Sandley mere, as its name implies, was formerly a lake; it is now a reedy flat, protected from the sea by only a broad beach of sand and pebbles, thrown up by the tide. Sometimes a swelling tide rushes over this unsettled barrier, enters the ancient mere, and would flow down the marshy level of the Keyingham drainage, by Rooss and Ridgemont, to the Humber, but for an artificial bank constructed under the management of the commissioners of sewers. As at Owthorne, the sea now flows over a part of the ancient bed of Sandley mere, and covers with sand much of its clay and peat. In this lacustrine formation, the bones of oxen and deer, with horns of the stag, &c. have been at different times discovered. The diluvial clay cliffs also furnish teeth of the elephant, in considerable plenty; which, being commonly picked up on the sand, are more or less worn by friction among the pebbles. It is remarkable that no other parts of the skeleton are found here.

The cliffs north of Sandley mere rise gradually, and, opposite Hilston, are about eighty feet high. Where they reach the height of sixty-nine feet, a very interesting deposit of fresh-water clay and shells appears on the top, for the length of two hundred feet. (See section G.) Its thickness is four feet eight inches; the upper two feet six inches consist of fine clay; below, are six inches of peat; then, six inches of clay perforated by roots; next, eight inches of clay, with plenty of Limnea stagnalis; two inches of peat, and four inches of a soft, yellowish earth. Beneath this deposit is the blue pebbly clay, which forms the mass of the cliffs.

Beyond Hilston, as far as Grimston garth, the cliff maintains the same composition, and, with some undulations, keeps the same elevation; but towards Ringbrough it falls, and becomes still lower beyond. Here a layer of gravel appears in the midst of the clay. Opposite East Newton the cliff is, at the utmost, sixty-seven feet high, but between this and Bunker's hill it falls to forty feet, and is covered by fresh-water deposits of clay, with blue phosphate of iron, peat, and curled black shale. The peat has produced abundance of hazel nuts. Bunker's hill, which is on the north, is seventy-nine feet high; from hence the cliff preserves, by Great Cowton and Mappleton, a nearly uniform height of sixty feet, till it sinks to the wide hollow opposite Hornsea. The general base of this whole cliff is the same blue and brown diluvial pebbly clay, and the only change in its appearance, which strikes the attention, is a more abundant diffusion of chalk pebbles in the northern part. It is almost invariably the case, that the blue part of this clay is at the bottom, and the brown above; but the joints of the brown variety are very often stained blue, apparently by water passing down them. At Great Cowton, a quantity of gravel lies above the brown clay; and in going along the shore, beyond Mappleton, I observed four separate fresh-water deposits on the top of the cliff, and in the middle of the clay a continued seam of gravel. Similar appearances continue to Hornsea gap.

The streams which pass by Hornsea fall into the sea through a wide depression of the cliffs, called Hornsea gap. The well-known lake called

Hornsea mere is one of the few sheets of water now remaining in Holderness, of the many which once existed there. When, if ever in future ages, the wasting action of the sea shall have extended inland so far as to reach and empty this lake, its bed, partly uncovered at low-water, will resemble the bottoms of Owthorne and Sandley meres.

The clay cliffs near Hornsea contain chalk and flint, with Belemnites mucronatus, and B. Listeri ; ammonites and other fossils from the lias of Whitby ; magnesian limestone from near Sunderland ; coal, sandstone, and mountain limestone, from the west of Yorkshire ; old red conglomerate, grauwacke, syenite with magnetic iron ore, quartz, septariate ironstone, &c. Teeth of the antediluvian elephant likewise occur on the shore, derived from some fallen cliff.

North of Hornsea gap, where a little gully divides the cliff, which is about fifteen feet high, we observe a small lacustrine deposit, thirty yards long, consisting of the following series, beginning at the surface ;

Lacustrine deposit.—Brown clay and soil. Peaty earth. Brownish marl. White marl, and shells, and plant roots. Beneath is gravel, resting on pebbly clay.

At a short distance beyond this place, (marked I. in the section,) the cliff is twenty feet high, and exhibits frequent alternations of gravel and clay, in a more regular order than is usually observed. Beginning at the surface, we have ;

1 Yellow and white small gravel of chalk and flint.
2 Brown clay, with very small fragments of chalk, flint, lias, magnesian lime, porphyry, &c.
3 As No. 1.
4 Layers of irony sand.
5 As Nos. 3, and 1.
6 As No. 2.
7 As Nos. 5, 3, and 1.
8 The general base of the cliff is blue clay and pebbles.

Hence the cliff rises, and before we arrive at Atwick it has attained the height of forty feet. Here a little gully divides the whole cliff, and crosses a fresh-water deposit of one hundred yards in length, (K). This consists of bluish and yellowish clay above, and whiter clay with shells beneath, resting on pebbly clay. Opposite Atwick is another such deposit fifty yards in length. At this place an elephant's tusk was found of extraordinary dimensions; it is preserved in the collection of Dr. Alderson, at Hull. The beacon on Skirlington hill, the highest point of the coast between Hornsea and Skipsea, is almost sixty feet above high-water. Hence it descends gradually northward, and, at a height of forty feet, we observe a fresh-water deposit ten yards in length. Further on, the pebbly clay sinks below the level of high-water, and forms a wide hollow, in which is an extensive and interesting lacustrine deposit, (L). Its length is about a quarter of a mile; its extreme elevation above high-water, at the south extremity, is twelve feet, but in the middle only four or five feet. The series of depositions from fresh-water is as follows:

Peat. Its utmost thickness is seven feet: where this happens, the lower four feet six inches are solid, and break like clay. The upper part is then fibrous. Yellowish clay, full of paludina tentaculata, cyclas cornea, c. lacustris, and a few specimens of limnea stagnalis. This is seen only on the southern side of the hollow. Blue clay, full of cyclades. Here is some phosphate of iron. This rests upon gravel, under which is blue clay.

In this deposit, an old man, who was employed in collecting gravel, accidentally discovered the head and horns of the great extinct elk, whose remains abound in the bogs of Ireland, and the Isle of Man. Subsequently, the lower jaw was discovered by the researches of Arthur Strickland, Esq. The horns are a little larger than the fine specimen in the Dublin museum, described by Mr. Hart, and measure eleven feet four inches by the circuit of the horns, and six feet eight inches between their tips, and there is a peculiarity in the brow antler, which I have never seen in any other specimen. It is expanded at the end, and furnished with *three* short digitations. The obliteration of the sutures of the cranium indicates the maturity of the individual, though from the perfection of the teeth, it does not appear to have been aged. This is the second and largest specimen of the gigantic elk which has been found

in Yorkshire. In the Philosophical Transactions for 1746, Mr. T. Knowlson describes and figures the head and horns of this animal from Cowthorp, near North Deighton, Wetherby. The horns were each five feet one inch long, and separated six feet one inch at the tips. The peat bogs and shell marl deposits in which the remains of this noble extinct animal have been found in Ireland, Scotland, and the Isle of Man, are extremely similar to the lacustrine accumulations of Holderness; as may be seen by reference to Mr. Hart's account of the discovery of the Dublin specimen; Professor Jameson's statements respecting the Edinburgh skeleton found in the Isle of Man; and Mr. Lyell's remarks on the shell marl formations in Scotland.

Beyond Skipsea the cliff, composed as before of the pebbly clay, attains a height of thirty feet, but soon sinks again to an extremely low part, where, for half-a-mile in length, a fresh-water deposit is seen, consisting of clay, with shells at the bottom. Between this point and the Barmston drain its height does not exceed twenty feet, and is generally as little as twelve feet. Three deposits of fresh-water clay appear in this space, and (at M) a mass of clay in undulated laminæ, which recalls the appearances under Kilnsea church. This undulated mass is separated from the pebbly clay by a layer of gravel. Beyond the Barmston water, (at N,) where the cliff is seven feet high, is a fresh-water deposit, of which the bottom seems almost to graduate into the laminated clay before-mentioned. The series here exhibited, is as follows:

Lacustrine deposit.—Washed sand and gravel, with some shells. Peat. Blue clay. Curled crisp shale. Laminated undulated clay, with small pebbles. Diluvial pebbly clay.

Further on, (at O,) the washed sand, above noticed, lies upon a dark peaty earth, which rests on contorted gravel. Under all, is the usual pebbly clay. On approaching Earl's Dike, the cliff (at P) is fifteen feet high, and is composed of sand accumulated from the road banks, brownish clay and small pebbles, sand and gravel, pebbly clay. Beyond Earl's Dike, the cliff, seven feet high, is composed of clay, resting on pebbly

clay, under a covering of gravel. At Owburne, nothing appears but the laminated clay; but, beyond, this rises into the cliff, and continues between the incumbent gravel and subjacent pebbly clay, all the way to Bridlington. It is well distinguished from the pebbly clay by the undulations of its layers, and by the extremely small size of the gravel which is mixed with it. I am induced to refer its origin to the diluvial floods, because of the extensive covering of gravel which here lies upon it; and there can be no better proof than this affords of the varied condition of those waters. For, in the cliff south of Bridlington, we behold at the bottom a great mass of amorphous clay, full of pebbles, derived from distant places in different directions, evidently brought together by a wide-spreading and mighty flood; above lies a more equal deposit from more quiet waters: and over all is spread a confused mass of gravel, composed chiefly of chalk and flint, derived from the neighbouring hills. At the bottom, we see the turbulent effects of rushing floods; above, the sediment of tranquillizing waters; and finally, the accumulations from a local current.

From the preceding description of the coast of Holderness, it is evident that no formations appear there which can be considered as belonging to regular marine strata. Of the diluvial accumulations, by far the most prevalent, that which is the base of the whole cliff, is blue and brown clay, containing dispersed pebbles; above this, a more local deposit of undulated laminated clay; and finally, gravel on the top, or mixed with the pebbly clay. In this formation lie the teeth and tusks of antediluvian elephants, and abundance of water-worn fossil shells, derived from neighbouring and remote districts. Resting on these diluvial beds, we find the deposits of later, more quiet, more contracted waters. Lakes, which existed in hollows of the deluge-worn surface, have been slowly filled up by clay marl, shells, and peat, subsiding from their waters, and either drained by the industry of man, or emptied by the approaches of the sea. The shells which occur in these clay beds, belong to freshwater species now living; they lie almost invariably at the bottom of

the bed of the lake, and are covered by several feet of clay and peat *without shells*, a circumstance which seems to warrant the supposition that the upper layers of sediment and peat were produced in some short period of time, in consequence, perhaps, of great land-floods.

In these deposits lie the skeletons of postdiluvian animals; the great extinct elk, the red deer, the fallow deer, and the ox; with trees and fruits, which grew in the forests they frequented. In more than twenty examples on the coast south of Bridlington, it may be clearly seen that the lacustrine deposits rest upon the diluvial accumulations; but are not themselves covered by any other deposit. It is a mistake, therefore, to imagine the skeletons of deer, and the peat and trees constituting the "subterranean forest" of Holderness, to be of the antediluvian æra. The shells, bones, and trees, belong, with a single exception, to species now in existence in this island, the deposits which enclose them are evidently the most recent in the country; and differ in no important particulars from the peat and marl-bogs of Scotland and Ireland, whose accumulation is not yet ended.

Tertiary beds.—One of the most important inquiries that presents itself to the geologist, whilst investigating the coast of Yorkshire, relates to the occurrence of any of the tertiary beds above the chalk, and Mr. Smith has stated, on his geological map of Yorkshire, that crag shells occur in the neighbourhood of Pattrington. These I have previously described, and cannot doubt that they belong to a more recent epoch. Professor Sedgwick, who examined the spot in 1821, describes appearances on the north side of the harbour at Bridlington, which he supposed to indicate the presence of some one of the strata above the chalk. I have repeatedly searched, without success, for these beds; but in July, 1828, I found, sixty yards north of the harbour, below the level of half tide, an enormous mass of dark shaly clay, whose laminæ seemed dipping to the south. It was several yards in length and breadth, was surrounded by brown pebbly clay, and contained a few fossils, amongst which were a peculiar ammonite; the columnar joints of pentac. briareus, and what I believe to be a form of avicula inæquivalvis. I

was at first much disposed to think this a portion of a tertiary stratum, and still am altogether at a loss to explain the appearance of so enormous a mass of perishable clay, having the appearance of lias at such a distance from the nearest cliffs of that stratum. I recommend this point for further observation. The specimens of pholas crispata washed ashore full of coherent sand, prove nothing whatever on this subject: such dead shells are particularly liable to be filled with the matter on the bed of the sea; and the only remarkable circumstance in these specimens is that the matter which they contain is unusually solidified. Excepting those imperfect indications, I have never heard of a single fact which would authorise a belief that tertiary strata exist in Yorkshire.

RISE OF THE CHALK.

No contrast can be more decided than appears between the solid, regular, continuous strata which have been formed by the repeated operations of a primeval ocean, and the mixed and irregular aggregations which mark the force and direction of subsequent diluvial currents on the surface of the earth. From Bridlington pier we look southward to a long line of wasting cliffs formed of detritus swept from the distant regions of the west and north-west, and our imagination is tasked to frame conjectures on the state of the land during and previous to all that violence of water;—whilst northward rise strata of chalk which, if compared to some other formations, must be called of recent date, yet were certainly deposited and hardened, and, in many places covered by several other rocks long before any considerable part of the surface of the earth, in these regions at least, was elevated above the sea. The considerations which belong to the two classes of phenomena are, in several respects, wholly different, and many geologists of good attainments have been content to study only one of them. The superficial deposits must, however, be both closely examined and viewed on a general scale, if we desire really to unveil the natural history of the earth. For such inquiries Holderness affords one of the best examples in the British isles.

As we proceed northward from Bridlington, the cliff, which near the town was twenty-five feet high, and consisted wholly of clay and pebbles, sinks to about ten feet, receives a covering of gravel upon the clay, and a few layers of lacustrine sediment upon the gravel. Here a small stream divides the cliff, and a chalybeate spring, issuing forth from the gravel, stains the sand with an abundant ochry deposit. Beyond, at a lime-kiln, the cliff is twenty feet high, and consists of gravel upon pebbly clay. The gravel abounds in chalk, and contains flint, quartz, porphyry, limestone, greenstone, &c. Nearly opposite the village of Sowerby, the bottom of the pebbly clay is seen resting on an irregular layer of chalk rubble, and the chalk itself rises from beneath, and ascends to some height in the cliff, which at this place is between seventy and eighty feet high. The beds of chalk rise to the north, and as we pass along the shore, other lower and different layers come up in succession, and expose a considerable number of fossils; amongst which we may notice sponges of many kinds, commonly called alcyonia, and others referred by Mr. Mantell to his genus ventriculites, echinida of the genera ananchytes, and spatangus, marsupites ornatus, and apiocrinus ellipticus. The marsupites are exceedingly abundant through a considerable thickness of the beds which appear towards the Danes' Dike; but the plates are generally scattered, owing to the decay of their connecting membranes before they were imbedded. The edges of the chalk layers are covered by a quantity of subangular chalk rubble, or gravel, mixed with a few rounded pebbles of other rocks: this is usually loose, but sometimes hardened into a conglomerate, not unlike that of Stenkrith in Westmoreland. Above all lies the usual diluvial mass of clay, pebbles, and sand; from which occasionally fall huge blocks of gneiss and basalt.

The Danish dike is an earthen rampart, running across the promontory of Flamborough from one side to the other. The southern part of this line follows the eastern side of a narrow and precipitous valley, which enters the sea between cliffs one hundred and nine feet high. At this place we obtain a clear proof of the high antiquity of valleys in the solid strata: for here the strata of chalk are deeply excavated beneath the mass of clay, and gravel, and sand, which was swept hither

during the rush of waters from the west. It is, therefore, not to be doubted, that such hollows are at least as old as that period. What effects may have been subsequently produced by the wearing of streams, the descent of rains, the course of floods, or the bursting of lakes, the present coast furnishes no sufficient data for discussing; perhaps, too little attention has been bestowed on this subject, since Dr. Hutton's opinions on the origin of valleys have been rejected as a general theory. I think I am acquainted with several instances clearly proving that in diluvial soils, and even in solid strata, small valleys have been excavated by the streams which flow in them, or else by the postdiluvian floods. But after examining the remainder of the section, and perusing the following descriptions, the reader will find no great reason to doubt that the valleys on the Yorkshire coast are generally as old at least as the diluvian æra, and that their principal features are due to great currents of water, directed along lines of fractured strata, or following other lines of least resistance.

Beyond the Danish dike, the cliff top continues at the same height to a little gully which descends from the village of Flamborough, but further on it rises greatly to the beacon, which is above one hundred and ninety feet from high-water. This great augmentation of height is not owing to any sudden change of dip in the chalk, but to an uncommon abundance of the diluvial matter which covers it. Around the beacon are several large boulders of granite, greenstone, fine-grained sandstone, &c. not less than three quarters of a ton in weight. Much chalk rubble is mixed with the diluvium of these cliffs. Descending by a rapid slope to the south landing-place of the Flamborough fishing-boats, we observe here, as at Danes' dike, the chalk strata deeply excavated beneath a thick cover of chalk rubble and diluvial clay. *

* Is it not probable that such a valley was excavated by a violent flood, of some duration and varying impetus, and that, as the force diminished, accumulations of clay and pebbles took place, and raised incessantly the bed of the current, till, all the accumulations having ceased, the valley gave passage to a regular small stream, which, in consequence of its rapid descent, reversed the operation, and cut its narrow passage deeper?

The chalk rubble and other gravel here, is often agglutinated into solid blocks. Beyond the south landing-place, the cliff, gradually bending round to the west, attains in one place the height of one hundred and thirty-six feet, and is mostly composed of solid chalk. Further on, where the chalk is depressed, and the diluvial clay thickened upon it, the cliffs are wasted by the sea, in a very remarkable manner: broad and lofty arches appear in the projecting masses, caves are formed, which open upwards to the day, and romantic islets of chalk are surrounded by the full swell of the waves. These appearances continue from the first pillar, called the Matron, to Selwicks bay, beneath the light-house; and the cliffs are decidedly most broken where the chalk is least elevated. The light-house appears to stand one hundred and sixty feet above the sea. Beyond Selwicks bay, layers of flint become very conspicuous in the chalk, and several curious indentations break the line of the cliffs, which are from one hundred and thirty to one hundred and forty feet high, between Selwicks bay and the north landing-place, in one of which rise two island pinnacles of chalk, called the King and Queen. The north landing-place of the Flamborough fishermen is a little hollow or bay of rocks, with a channel for boats at low-water, and a gravelly beach. Here are caves in the depressed chalk, worthy of examination by the lover of scenery, and the geologist.

The origin of many inland caverns in limestone is exceedingly obscure. Though water flows through many of them, and by incessant attrition smooths their surfaces, and modifies their forms, yet, perhaps, we ought rather to believe that the cave, previously existing, directed the course of the stream, than that water excavated the cave. By the sea-side it is otherwise; the destructive action of the sea is not doubtful; the cliffs crumble before its salt vapours, and waste away under its furious waves. One loosened stone beats down another, and thus the soft parts are hollowed out, whilst the harder portions jut into promontories, or stand naked in the water. If the soft parts, exposed to the waves, be enclosed in firmer matter, caves and arches are formed, which are afterwards liable only to slow alteration; but if these yielding materials extend far in a horizontal direction, the cliff undergoes rapid

diminution. These observations are of general application. Projecting capes and headlands are usually composed of firmly-compacted strata, whilst bays and estuaries commonly present less resisting materials. Between the north landing-place and a more remarkable bay to the west, the prominent cliffs are one hundred and seventeen feet high, and mostly composed of chalk; but at both these bays that stratum sinks low, and is covered by a vast accumulation of diluvium. These unsolid materials fall and waste away into slopes, which often become covered with grass, and afford a dangerous pasture for cattle and sheep. But, on the west side of the remarkable bay before alluded to, the diluvium is subject to such continual waste, that it appears in the form of bare pinnacles resting upon the caverned chalk.

From the last-mentioned point the chalk cliffs rise rapidly to Danes' dike, which is two hundred and ninety-two feet above high-water, then sink again by the summer house, to a point which displays the most remarkable contortions of the strata known on this coast. As may be seen in the section, the chalk layers are here bent in sigmoidal flexures, whilst on each side they are perfectly horizontal. On the eastern side this horizontal direction changes to a rising arch, from which again the layers descend in long perpendiculars, to join the depressed arch which is connected with the horizontal layers on the western side. This remarkable confusion of declination occupies the whole height of the cliff, (two hundred and forty feet,) but its horizontal length is small. I could not determine what amount of dislocation is occasioned between the horizontal strata which enclose these contortions; nor, indeed, whether any such effect is produced. It is scarcely possible to conceive how such flexures could be produced, except when the strata were soft and yielding; and it seems reasonable to suppose that they are nearly coeval with the deposition of the chalk. As in many other instances, the diluvial matter lies without any distinction or peculiarity, upon both the regular and the disturbed strata.

About a mile further is the highest point of the "white cliffs;" and here, at an elevation of four hundred and thirty-six feet, a beacon, I

believe, once stood on the very brink of the precipice. A considerable part of this surpassing altitude is owing to an unusual thickness of diluvium which here covers the chalk. The views from this station are very extensive; a long line of coast divides the area into two semicircles of land and water: one half the horizon is sea, and the remainder stretches from the heights above Robin Hood's Bay across the moorlands to the oolitic hills, and then pursues the southward sweep of the wolds, till hills and plains are mingled in the distance. We then descend for about a mile to the last of the white cliffs, three hundred and eighty-two feet high. The range of chalk here quits the sea-coast, and proceeds inland by Speeton beacon, four hundred and fifty feet, above Hunmanby, and along the south side of the vale of Pickering, rising higher and higher towards the west, till it attains its extreme height near Garraby beacon, eight hundred and five feet above the sea. From its last high precipice the chalk descends along the shore by an irregular broken escarpment covered with diluvium, and at length its lowest layers are seen. These are always characterised by an admixture of red chalk containing the very peculiar belemnite, which Dr. Lister noticed so long ago, as occurring, *semper in terrâ rubrâ ferrugineâ.** Serpulæ, small inocerami, and terebratulæ have been found in this red chalk.

To complete our description of the chalk cliffs, we may notice that the chalk rubble, which so uniformly covers the stratum on the south side of Flamborough head, is hardly ever seen on the north side. Caves abound in the northern cliff which are exposed to the full rush of the sea; but not on the southern side, where the water is more calm. Organic remains are very abundant in the upper part of the stratum between Bridlington and the south landing-place; but the lower and harder chalk contains hardly any other fossil than the inocerami. Upon the whole, the chalk of Yorkshire is comparatively poor in fossils.

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* For want of examining the localities which he indicates, geologists have often given the name belemnites Listeri to a very different species, (Smith, "*Strata ident. Brickearth,*" *fig.* 4, and 5,) and assigned Lister's fossil to the gault and weald clay.

About forty species only have yet been found in it, whilst thrice that number have rewarded the collectors in Norfolk, Wiltshire, Sussex, and Kent.

CLIFFS OPPOSITE THE VALE OF PICKERING.

From the termination of the white cliffs the coast bends to the northward, and exhibits in succession, rising from beneath the chalk, the Speeton clay and the coralline oolite series. The Speeton clay shews itself immediately in contact with the red chalk, so that there can be no question of its being the next subjacent stratum; and therefore it will be useless to look for the greensand formation in this part of Yorkshire. The sand represented on Mr. Smith's map of Yorkshire, as ranging on the south side of the vale of Pickering, is merely superficial: blue clay is found at too many points in contact with the bottom of the chalk, to leave the slightest doubt on the subject. At Speeton the clay is dark and laminated, with distant layers of nodules of argillaceous ironstone, the larger of which are fissured within, and have these fissures either empty, lined with crystals of selenite and iron pyrites, or filled up with calcareous spar. Such large nodules occasionally contain ammonites and fragments of hamites. The smaller oval nodules frequently enclose small crustaceous animals, having the general appearance of the genus astacus, but with attenuated fore-legs, and slender sub-abdominal processes. A great number of very interesting fossils, which will be described hereafter, have at different times been found in the clay at Speeton. Among the most curious, are a fragment of a jaw containing four rows of (molar) teeth in situ, in the possession of its discoverer, C. Preston, Esq. of Flasby, teeth and vertebræ of saurian animals, many beautiful ammonites, hamites, and nuculæ, which ornament the cabinets of Mr. Bean and Mr. Williamson. To make any tolerable collection of the beautiful fossils of Speeton requires patience and assiduity; for though they are really not scarce, yet it is only after rains have exposed a fresh surface that they can be found in plenty.

Several remarkable fossils, which Mr. Mantell describes from the gault of Sussex, are found at Speeton; and generally a great analogy may be perceived between the fossils of the blue clay of Speeton and Knapton, and those which belong to the argillaceous beds which lie beneath the chalk in Kent and Sussex. But some of the Speeton fossils bear so great a resemblance to those of the Kimmeridge clay, that Professor Sedgewick has been led to refer them to that stratum. The evidence on this subject may be more completely unfolded in the chapter devoted to organic remains; but, in the mean time, I may state, that my observations lead me to refer at least the upper part of the Speeton clay to the gault of Cambridge and Sussex; and I have before said that the lower argillaceous range along the north side of the vale of Pickering, belongs to the Kimmeridge clay.

Like the chalk under which it sinks, the Speeton clay dips southward. It is exposed in the broken cliff to an elevation of two hundred feet, and I had once, (1826,) in a particular condition of the tides, an opportunity of seeing some harder beds than common, with compressed ammonites at low-water mark. Some remarkable contortions of the clay, which appear on the shore towards its northern termination, are represented in one of the detached sections. It is covered, even where highest, by a great quantity of diluvial clay and pebbles; and as we proceed northward, it sinks continually, and, in less than a mile from its first appearance, is lost below the level of the sea. The cliffs which succeed as far as Filey, are much varied and broken, and consist of diluvial clay and pebbles; but blue clay, containing belemnites, shews itself in one or two places, as drawn in the section. On approaching Filey, we observe on the cliff top, seventy-eight feet high, a small lacustrine deposit, which occupies about one quarter of an acre. It consists of light blue clay, peaty clay, blue clay, white clay, and peat, altogether four feet thick, upon sand and gravel.

It deserves remark, that the diluvial clay north of Flamborough head is decidedly of a redder colour than that which is found in Holderness. This circumstance is very evident in Filey bay, where the

cliffs afford few other subjects of observation, till at the northern promontory the oolitic rocks emerge from the sea, and form the long reef called Filey Brig.

CLIFFS OF THE OOLITIC SERIES.

THAT at some former period the strata which emerge from beneath the vale of Pickering, in ridges sloping to the south, but precipitous toward the north, have had their surfaces exposed to the ravages of water, is evident by inspecting the cliff above Filey brig. For here the diluvial clay, rising to the height of one hundred and six feet, rests upon the lower beds of coralline oolite, which immediately cover the lower calcareous grit. (See p. 2, for a statement of the complete series.) The remainder of the oolite and the upper calcareous grit above it, which occur *in situ* a few miles inland, had been removed before the diluvial matter was laid upon the wasted surface of the remaining rocks.

In the enlarged section of these appearances, it will be seen that the diluvium rests on rubbly oolite, five feet in thickness; beneath are two beds of solid oolitic limestone, (occasionally separated by two feet of a soft, yellow, calcareous grit,) which contain clypci, lutrariæ, trigonia costata and clavellata, pecten viminalis, pecten vagans, gryphææ, melaniæ, &c. This limestone, which belongs to the upper oolite, rests upon the calcareous grit, of which beds to the thickness of sixty feet rise from the sea, within the distance of a quarter of a mile. In the upper part of the rock lie a few alternations of limestone; and both these and the grit beds contain most of the fossils which occur in the oolitic layers above, excepting perhaps the echinida. The surfaces of the beds of calcareous grit are singularly characterised by ramified masses of doubtful origin, which appear like dichotomous cylindrical sponges. Below twenty-five feet of this rock lie nine feet of soft, yellow, sandy stone, containing large spheroidal, highly-indurated, calcareo-siliceous balls. This band of soft sand and hard balls may be traced for a great distance, along the

perpendicular rocks which rise from Filey brig, under a cover of diluvial clay and pebbles, to the summit of Gristhorpe cliff. Under them runs a considerable thickness of calcareous grit beds, which above are hard, rough, and cherty, but beneath become soft, gray, and argillaceous, indicating the change to the Oxford clay. About three quarters of a mile from Filey brig, the Oxford clay appears, and soon afterwards the sandy and irony Kelloways rock and the argillo-calcareous cornbrash beds rise into the cliff.

GRISTHORPE CLIFF,

Two hundred and eighty feet above high-water, presents the following section :

	Feet.
Diluvial clay and pebbles	8
Lower part of the calcareous grit	30
Gradations between calcareous grit and Oxford clay	40

	Feet.	
Oxford clay	120	These will be particularly described, when we come to treat of the castle-hill at Scarborough.
Kelloways rock	25	
Clay and cornbrash rock...	5	
Carbonaceous shale and sandstone	50	

Between Gristhorpe and Red cliff, the upper strata have been removed from the shore, and the wide hollow so produced partly filled by diluvium ; but the Kelloways rock and the carbonaceous shale and sandstone, still rising northward, allow the oolitic limestone beneath them to appear at low-water between a remarkable rock surrounded by the sea at high-water and Red cliff. The relative position of the several rocks may be gathered from the general section, and the particular characters of the carbonaceous sandstones and shales, and the inferior oolite, may be understood by consulting the enlarged representation of this interesting spot.

Here in the upper part, above the layer marked *h*, we observe towards Red cliff the same shales and thin sandstones which were

noticed at the base of Gristhorpe cliff; and below, the beds, *h*, *g*, *f*, *e*, *d*, are so many portions of the sandstones and shales which lie at the bottom of that carbonaceous series. *a* is the oolite.

I shall describe them in a reversed or ascending order.

a. The inferior oolite, its top level with high-water, in thick, solid, obliquely laminated, partially oolitic beds, with oxide of iron in the partings. It is full of fragmented millepora, crinoidea, and echinida. The upper surface is covered by a dichotomous millepora. This rock closely resembles that which occupies the projecting point called Ewe nab, north of Cayton bay.

c. Argillo-arenaceous layers, separated by carbonaceous partings, containing some ironstone nodules, and small white shells, especially in the upper part. This is excavated by the sea along the shore in a hollow course between *a* and *d*.

d. 1. Solid beds of ironstone nodules, from three feet six inches to four feet six inches thick.

2. A parting of shale, with imperfect plants.

3. Sandstone in confused beds, with laminæ of shale and carbonized wood; its surfaces and partings irony.

e. 1. Black sulphureous shale, with selenite and layers of coal, formed from wood. Here a multitude of fossil plants is found.

2. The thickest of several sandstone layers.

3. Black and white shale.

f. Sandstone laminated.

g. Very dark shale.

h. Confused sandstone and shale.

i. Alternations of thick sandstone and thicker shales.

These oolitic rocks sink below low-water before reaching Red cliff, and all the strata above it bend a little downwards, and successively form scars; but suddenly the scars are all terminated by a straight line. On tracing this line backward to the cliff, we find it connected with a very remarkable dislocation or slip of the strata, which may be understood from the representation in the general section. On the left of the line of this dislocation, the lower part of the Oxford clay is opposed to the bottom of the calcareous grit on the right; the Kelloways on the left meets the top of the Oxford clay on the right, whilst the Kelloways on

the right meets the carbonaceous sandstone and shale on the left. The extent of the dislocation is about one hundred and forty feet; its direction agrees with the well-known observation of miners, that "the fault dips or underlays on the sunken side:" an observation to the truth of which I have never *seen* an exception.

RED CLIFF

Which is immediately beyond this fault, is two hundred and eighty-five feet above high-water, and consists of the same strata as Gristhorpe cliff, but the carbonaceous shale at the bottom scarcely appears. The calcareous grit beds at the top consist of the lower portions of that rock, and beneath them are the gray alternations, which so gradually change into Oxford clay, that no very distinct line can be drawn. The Kelloways rock beneath is very completely exhibited, with a thickness of near thirty feet, and the cornbrash with its characteristic fossils comes out from beneath. All these strata are cut off, and made to terminate abruptly, by the rapid descent from Red cliff to Cayton mill; beyond which is an unexpected cliff of calcareous grit, sunk upwards of two hundred feet below its general level, and based on the Oxford clay. No doubt this is owing to some ancient subsidence or sliding of a part of the hill above. Immediately beyond, rises the lower portion of the carbonaceous series, and, at the prominent point called Ewe nab, ascends so far into the cliff that the oolitic beds, which were before seen at the island on the north side of Gristhorpe bay, appear above the level of high-water.

The oolitic beds which here present their huge blocks to the waves, are so very similar to those described near the above-mentioned island, as to need no additional description, further than to notice that the millеporæ are here broken and less plentiful, and shells perhaps not so scarce; but the carbonaceous beds above them are different. (See the enlarged section.) The reversed series is as follows:

a. The oolitic limestone filled with fragments of coral, crinoidea, echinida, and shells.
b. Soft yellow sandstone with ochry balls.

c. Laminated sandstone.
d. Block sandstone.
e. Alternations of sandstone and shale.
f. Diluvium.

These beds bend down towards the north, and the whole series suddenly disappears, beyond the point of Ewe nab, with indications of a fault. Carbonaceous shale and sandstone, mixed with much diluvium, occupy the low sea cliffs of Carnelian bay, and above are irregular broken slopes of diluvium. These appearances continue to the point of rocks called White nab, where the tide flows round a little island, as conspicuous as that formed of the same strata at the north point of Gristhorpe bay.

As at the island, and at Ewe nab, so at White nab, the oolitic beds rise gradually from the south to a moderate height, and again fall gently towards the north. The series here exhibited is drawn to scale in the enlarged section.

a. Represents the rough argillo-calcareous beds with layers of septariate ironstone, full of shells, and interspersed masses of soft large-grained oolite. The uppermost layer is soft and shaly.
b. The carbonaceous sandstone series.
1. A regular bluish or yellowish bed, occasionally fissile; it then contains a few casts of bivalve shells, becomes very calcareous, and much resembles the "roadstone" of Brandsby.
2. In this layer of sandstone lie equisetiform and other plants, besides large branches of wood.
3. Mass of carbonaceous sandstone, with irregular interpolations of shale.

A complete catalogue of the fossils found at the White nab will be given in the latter part of this work. It may be sufficient now to mention that gervilliæ, aviculæ, and short thick belemnites are among the most common.

Proceeding along the shore, we find the calcareous and ironstone beds exposed in broad flat scars at low-water, and extending, with some interruptions, to Ramsden scar, nearly opposite the bathing machines

at Scarborough. The lower part of the cliff, from White nab nearly to the Spaw, is kept by the carbonaceous grit, and above, in irregular often grassy cliffs, lie the carbonaceous shale and thin sandstones: the highest point of this inland cliff, opposite Wheatcrofts farm, two hundred and seventy-eight feet high, is capped by the cornbrash and Kelloways rocks. The calcareous and irony strata have their long, straight, intersecting fissures often lined with double laminæ or septa of oxide of iron, between which sometimes occurs a white, compact, soft, smooth substance, which the Rev. W. V. Vernon ascertained to be a compound of alumina and silica. Exactly similar septa, and occasionally the same aluminous substance, occur in the superincumbent variable bed of sandstone; and in addition, this bed presents a number of ochraceous belts or zones parallel to the margins of its blocks, thus beautifully variegating the blue or white colour of the stone.

It is very interesting to observe, in this walk along the south sands of Scarborough, between White nab and the spaw, the peculiar appearances of the carbonaceous sandstone. The frequent and remarkable curvatures of the beds, the unequal intermixture of shale among them, and the dispersion of carbonaceous fragments through the mass, leaves no doubt of the agitation of the water which left this curious deposit. The accumulation of diluvial matter increases continually northward, from the high point of Kelloways rock opposite Wheatcrofts, and it occupies the whole cliff from the spaw to the bridge. It is, in general, clay filled with pebbles of all kinds and magnitudes; the largest masses are either Shap-fell granite, mountain limestone, or basalt. Among the most abundant are porphyries; of which some belong, I think, to the Cumberland mountains, others may, perhaps, be referred to Scotland. The agates, which have been transported along with trap rocks from Scotland, or the north of Europe, are comparatively rare. In a few places the diluvial matter swept from some particular line of country, seems to be exclusively aggregated together. This is well seen behind the spaw, where the gravel consists almost entirely of framented lias and moorland sandstones. Here lie many ammonites, pectines, gryphææ, &c. characteristic of the lias formation.

In cutting the cliff above the terrace walk at Scarborough, a seeming dislocation in the diluvium has been exposed. If the appearances may be trusted, two layers of wet sand have been depressed several feet on the northern side. But the inequality of the depression in the two layers, and the seeming dislocation not extending into the gravel beneath, are circumstances never observed in a determinate dislocation of strata. The cliff over the spaw varies from one hundred and fifty-one to one hundred and seventy-one feet in height above high-water.

That part of Scarborough emphatically called the Cliff, is from ninety to one hundred and ten feet above high-water; from hence the slope grows continually flatter to Bland's cliff, and beyond this point the whole shore is occupied by streets as far as the commencement of the outer pier. Here the steeps of the castle-hill rise suddenly from the water, and, further on, reach an elevation of two hundred and seventy feet; but part of the castle garth is, perhaps, fifteen feet higher. The first rock which is seen above the pier is a ferruginous sandstone with fossil shells, which is ascertained to be identical with the rock of Kelloways in Wiltshire. Above lies the gray argillaceous earth which occupies the place of the Oxford clay; this gradually passes into the calcareous grit, and some beds of the coralline oolite surmount the whole. These strata decline in the eastern face of the hill, so that the Kelloways rock sinks below the level of high-water, and at a projecting point the Oxford clay keeps the foot of the cliff; but soon rising again, where the hill fronts the north, they ascend towards the drawbridge. The fort on the northern face of the hill is levelled on nearly the lower beds of coralline oolite; of this rock thirty feet appear on the hill above; its whole thickness here is nearly forty feet; below are about eighteen feet of solid calcareous grit beds; these rest on three layers of hard calcareo-siliceous balls, lying in soft yellow sand, twenty-eight feet thick: then succeed fifty feet of calcareous grit, hard above but graduating below to the next stratum, the Oxford clay; which, being one hundred and thirty-five feet thick, occupies the remainder of the hill to high-water mark.

These strata, rising towards the drawbridge, have been subjected to a very uncommon dislocation, the effect of which is the uplifting of the Kelloways rock to the level of the lower part of the calcareous grit. Kelloways fossils are found in this uplifted portion on the north side of the drawbridge,* two hundred feet above the sea. This uplifted portion is very narrow, and it is not nearly so distinct as, from necessity, the general section represents it. Bushel's fort is upon the lowest soft part of the calcareous grit, which can hardly be distinguished from the Oxford clay. The stratum so named is found in the upper part of the cliffs beyond; whilst below it occurs the Kelloways rock, rich in ammonites, gryphææ, aviculæ, &c. The cornbrash is found beneath, full of terebratulæ, unioniform shells, trigoniæ, ostreæ, &c.; and its blocks, strewed on the sands, afford a rich harvest to the geologist. Still lower are the shales and sandstones of the carbonaceous grit. Scarborough castle-hill, therefore, agrees in general composition with Gristhorpe and Red cliffs, but its summit is crowned with the oolite which does not occur on them. Further; since in none of the cliffs from Filey to Scarborough do we find any of the superior calcareous grit, which is found above the oolite near Kirby-Moorside and Helmsley, it is certain that on the Yorkshire coast this oolite series is imperfect, by the deficiency of its upper members. That such deficiency is aboriginal, no one will suppose, who considers the deep-cut valleys and vast heaps of diluvium in the country about Scarborough; for these bring irrefragable testimony to the effect of widespreading and powerful denudations. In order, therefore, to gain a complete knowledge of this oolitic formation, it is necessary to study the coast and the interior together; the cliffs against the sea must be compared with the quarries and watercourses inland, before such a table of stratification can be prepared as I have given in the previous pages of this work. Moreover, it must be observed, that nowhere on this coast do we find those lowest layers of the Kimmeridge clay, which at Kirby-Moorside and west of Helmsley furnish the characteristic ostrea delta.

* Mr. Smith discovered this singular fault, and communicated it to me: his eagerness on the occasion led him to overstrained exertion; and the consequences was a very alarming privation of muscular power in his legs; from which his friends have since rejoiced in his perfect recovery.

These beds have yielded to the same diluvial impetus. But, with these exceptions, the series on the coast is complete, from the top of the chalk to nearly the base of the lias, and junctions may be examined of all the adjacent strata.

As the Oxford clay, Kelloways rock, and cornbrash, are nowhere on the coast better seen than at Scarborough, and as we shall have no other opportunity of noticing them, till we come to treat of their organic contents, I shall take this opportunity of adding some notice of their general character and appearance.

The chief reason for giving the name of Oxford clay to the gray argillaceous earth of Scarborough castle-hill, is its position between the well-determined strata of calcareous grit and Kelloways rock; for, independently of this circumstance, no particular affinity can be traced between the friable and rather sandy shale of Scarborough, and the tough blue clay of Oxford and Wiltshire; and the fossils of both situations are yet but imperfectly known. It is probable, indeed, that my enumeration of the fossils found in this stratum at Scarborough, by Messrs. Bean, Dunn, Smith, and Williamson, may be found more extensive than a similar catalogue of those belonging to it in the south of England; and yet only a few years have elapsed since it was discovered to contain any.

The Kelloways rock agrees much better with its prototype both in substance and organic remains. It is, indeed, seldom that specimens of mixed secondary sandstones, procured from neighbouring parishes, are more similar than some which may be selected from this stratum in Wiltshire and Yorkshire; and so complete is the affinity of the imbedded fossils, that it might be easy for the most practised eye to mistake the one for the other. In Yorkshire, the Kelloways rock is a mixed sandstone, containing some carbonate of lime and some argillaceous particles of a grayish yellow colour, changing to greenish gray when wet, and to brownish yellow when much impregnated with oxide of iron. The difference in its state of consolidation is singular: in some places it consists of loose unaggregated sand, containing hard, irony, and cal-

careous masses. At Hackness alone it is worked as a building stone: it is there very soft in the quarry, and may be chiselled and wrought with the utmost facility. It has at the same time, the property of hardening by exposure; and, possessing both beauty and durability, is a very valuable building stone. Its durability is evinced by the condition of the stone in the ancient church at Hackness, which was probably built about the end of the thirteenth century, and its good effect in architecture may be seen to great advantage in the new Church and new Museum at Scarborough, and especially in the Museum of the Yorkshire Philosophical Society, in the construction of which blocks of great magnitude have been employed.

Its thickness is generally above thirty feet: the upper bed is usually very thick, hard, and irony, full of gryphææ, belemnites, &c., so as to be unfit for building. In the quarry at Hackness, the ammonites Calloviensis, Kœnigi, sublævis, &c. which so eminently characterise the stratum, lie on the top of the rock just below the Oxford clay. At Scarborough, they lie a little deeper in the stone. On account of its comparative hardness, the upper beds of this rock project on the hill sides beyond the slopes of the incumbent clay, and form little buttresses beneath those remarkable "nabs" by which the calcareous grit is recognised in the vicinity of Scarborough.

That stratum of the oolitic series, which, in the south of England, Mr. Smith named the "cornbrash," is well known to be a very variable rock as to its substance and thickness, but remarkably well characterised by its fossils. It is by their aid that we have traced this thin and otherwise unimportant rock, with hardly a single interruption, from Dorsetshire to Lincolnshire. It is, therefore, by organic fossils and geological position alone, that we can expect to recognise the cornbrash on the coast of Yorkshire. By these characters, it may be satisfactorily identified: it usually appears as a single, thick, fissile, calcareous bed, lying almost in contact with the bottom of the Kelloways rock; but eminently distinguished from it by the nature of its substance, and the shells with which it is filled. Without close attention, so thin a layer can hardly

be traced along the cliffs; and it is, therefore, not surprising that its inland course is rather assumed than proved. Below it is the carbonaceous series of shales and sandstones, whose northward extension remains to be described.

CLIFFS NORTH OF SCARBOROUGH.

From low-water mark on the shore, beneath the drawbridge, the carbonaceous shale rises gradually, till at length, the cornbrash having terminated, it possesses the whole stratified portion of the cliff; but a great quantity of diluvial clay and pebbles lies upon it, thickening towards Peaseholm beck. The hill beyond, on whose slope are some entrenchments commonly termed Oliver's battery, is likewise composed of diluvium resting on shale and thin sandstones; and this character continues to the opening at Scalby beck. Here, on both sides of the stream, is a very interesting occurrence of granular iron ore, in a solid, nodular bed, interlaminated with the sandstone. The cliffs from Scalby beck to the projecting point south of Cloughton Wyke are all less than one hundred and thirty-five feet in height, and, as will be seen by the colouring of the section, are all composed of diluvial sand and sandstone gravel, resting upon shale and sandstone. The sandstone forms a series of low-water scars, on which it is interesting to trace the contrary courses of the beds, depending on their irregular flexures and inclinations. Before arriving at Cloughton Wyke, the lower and thicker beds of sandstone above-mentioned rise to the summit of the cliff, and leave the shore to be occupied by the argillo-calcareous and sometimes oolitic beds, full of shells, which represent the oolite of Cave and Lincolnshire. The series here laid bare in the cliffs and on the shore is the following;

a. Block sandstone, on the top of the cliff, irony, and often spotted with carbonaceous fragments.

b. Shale, which wastes from under it. In the upper part principally lie the ironstone balls.

c. Nodular, rather shaly, calcareous bed, full of shells, five or six feet; the joints sparry and ochry.

d. Shale, one foot six inches.

e. Nodular bed like *c*, full of shells.

f. Shale, two feet six inches.

g. Soft calcareous layers full of shells.

h. Series of fissile and solid subcalcareous sandstones, ironstone, and calcareous shale beds, here and there containing fossils. Some beds waved like the tide-worn sand, others full of ramified masses, very like but smaller than those in the calcareous grit.

These beds continue rising in the cliffs which encircle the bay of Cloughton Wyke, where incrustations happen from the water falling over them, and, beyond, ascend to the summit of the far loftier cliffs between Cloughton and Haiburn Wyke. That part of these cliffs where the little colliery is established is two hundred and forty feet high, and exhibits the following beds below those enumerated above:

i. Black shale.
k. Solid sandstone.
l. Black shale.
m. Sandstone.
n. Shale.
o. Sandstone.
p. Shale & coal. { Coal seam, 1 ft. Black shale, 1 ft. 6 in. White shaly stone, 1 ft. 6 in. Shale & sandstone.
q. Sandstone.
r. Shale.
s. Sandstone.
t. Shale.
u. Sandstone at the cliff foot.

This coal seam, beneath the gray oolite, is pretty extensively wrought in the interior moorlands, as at Maybecks on the Sneaton estate near Whitby, and in Danby beacon. The strata which come below these cannot be well traced towards Haiburn Wyke, though the cliff is three hundred and thirty-one feet high, because of a slip or sunken portion of the precipice, much overgrown with shrubs and disguised by loose blocks. There is a dislocation, perhaps a double one, at Haiburn Wyke, and I am not certain that the sandstone beds on the opposite sides are correctly referred to their respective relative situations; but the section was drawn after three careful examinations of the place. If it be correct, there are two faults, one running on each side of the little insulated cliff, and raising the strata a few yards on the south side.

THE cliffs which begin on the north side of Haiburn Wyke are loftier than any which have hitherto claimed our attention. They continue rising with altitudes of two hundred and ninety-six, three hundred and eighty-seven, and four hundred and ninety-seven feet, to the High Peak which is about five hundred and eighty-five feet above the sea. In the middle of this high range, the uppermost rock is the carbonaceous gritstone so frequently mentioned, and below it a series of limestone, shale, and sandstone, corresponding to those already enumerated at Cloughton Wyke. Lower beds than these also appear at the northern and southern extremities, but are obscured in the middle by what seems to be a very extensive slip of the superior heights, forming an "undercliff."

As in a part of the Stainton cliffs the carbonaceous sandstone is seen lying upon the oolitic series, whilst at Blue Wick below the Peak the lias appears, we obtain by uniting the observations the following section of nearly the whole of the moorland series of rocks.

Feet.		
40	*a.*	Carbonaceous grit, containing black shale in lumps and layers, bits of carbonized wood, and striated culms, but apparently different from those of High Whitby. This rock is quarried on the edge of the cliff.
30	*b.*	Shale of a dark colour.
	c.	Shelly limestone, with large short belemnites.
	d.	Shale.
	e.	Nodular shelly beds, like *c.*
40	*f.* Shale, *h.* Sandstone, *i.* Shale, *k.* Sandstone, *l.* Shale, *m.* Sandstone,	Apparently corresponding to the sandstones and shales so marked in the section of Cloughton Wyke.
90	*n.* Shale, *o.* Sandstone, *p.* Shale,	Corresponding to the rocks so marked in the section of Cloughton.

Feet.

60 *q, r, s.* Mostly sandstone beds, forming a rock about sixty feet thick, which may be traced without interruption from Haiburn Wyke to the summit of the cliff at the Peak; and from that point it appears on many of the cliffs to the northward, and constitutes what is called the "cap rock" of the alum shale.

The series below, to the lias, varies much in the arrangement of the beds of sandstone and shale, and still more in their aggregate thickness.

Feet.

200 A series of shales and sandstones in very frequent alternations, the former predominating so as to cause the cliff to waste, and generally to slope from the cap rock above to the sandstone series beneath: in a part of this series at Haiburn Wyke lie fossil plants resembling cycadeæ, ferns, equiseta, &c.

60 Grit rocks and thin shales in irregular succession, and of various thicknesses. They generally appear thus:

20 feet of grit of a white colour.
6 to 10 feet of shale.
20 feet of grit, at its bottom is ironstone, containing various plants, as cycadiform fronds and ferns.
10 feet of irony and carbonaceous shale.

Conchiferous *(dogger)* series, analogous to the inferior oolite of Bath. This is best exposed at Blue Wick, and contains the following beds, in the same downward order. (See the enlarged section.)

Feet.

30 Fine-grained, yellow micaceous, irony sandstone, in large blocks variously bedded and jointed; containing several layers of pebbles and shells: (represented in the enlarged section by dotted lines:) the upper one very ochraceous and full of many shells, as turritella muricata, and t. cingenda, actæon, trigonia, astarte, &c. The top is very irony, but without shells. A parting of shale, ironstone, &c.

20 Fine-grained, yellow, micaceous sandstone, in blocks of various forms, with nests or irony masses of serpulæ, lingulæ, &c. represented by dotted lines.

Feet.

20 Gray, micaceous, soft, argillaceous sandstone, mostly fissile, but not regularly plated like the alum shale, to which it gradually changes in the lower beds: divided like the lias by long joints, and filled with subramose masses of the same substance, not unlike the beds at Cloughton. These beds form the scars which stretch from Blue Wick a short distance southward. On their surfaces lie irony nests of serpulæ, belemnites, aviculæ, pinnæ, &c.

Below are the rough, sandy, upper beds of lias shale, which lower down become regularly fissile, and are full of ammonites, belemnites, unioniform shells, &c.

LIAS CLIFFS.

From Blue Wick, where it first appears, the lias formation is seen along the whole shore by Whitby, Runswick, Staithes, Boulby, and Saltburn, and is every where washed by the sea, except in the space between Whitby and Sandsend where it is depressed by extensive dislocations. In consequence, the cliffs assume a different appearance from those already described, and present different phenomena. Stupendously abrupt and separated by a very narrow space from deep water, it is often hazardous, and sometimes impracticable, to examine them from beneath. They vary in altitude, according to the character of the inland country, and the pile of strata in the cliff. The great height of the Peak is owing to the truncation of the high ridge of Stow brow; and the superior elevation of Boulby is accompanied by an accumulation of the sandstone rocks at the top. There is no example from the Peak to Saltburn, where any sandstone higher than the cap rock appears in the cliff. Some of these strata do, indeed, appear at a short distance inland, as the oolitic limestone near Hawsker bottoms, but they never reach the sea-shore; and in our future descriptions we shall, therefore, notice only the subdivisions of the lias, and the variations in its sandstone covering.

Proceeding northward from Blue Wick, we find the lias rising with extreme regularity to some distance beyond the Peak house, where it

attains an elevation of two hundred and seventy feet above high-water. A sunken portion of the precipices here forms an undercliff, and leaves only the upper part of the lias exposed below the conchiferous and plant-producing beds before described. But immediately beyond, the scene changes, a great dislocation has happened, and the lias beds are uplifted on the northern side of it, to such a degree that some conchiferous beds, which are usually four hundred feet deep in the lias, appear considerably higher than the top of that formation on the south. This will be readily understood by referring to the section.

The uppermost of the beds thus exposed on the north side of this great dislocation, belong to a thick series of sandy and irony conchiferous strata, which divide the lias clay or shale into two principal parts, henceforward to be termed upper and lower lias shale. The upper one, as being peculiarly appropriated to the production of alum, is termed the alum shale. These interposed strata are identical in geological characters with the marlstone of Lincolnshire, Rutland, and the midland counties. In all these counties the marlstone is wonderfully prolific in fossils; and we shall find in the sequel that it is equally productive in the Yorkshire cliffs. At the Peak, about forty feet of this series appear, and yield abundance of terebratulæ, dentalia, aviculæ, &c. Below these sandy beds is an immense escarpment of more than three hundred feet, composed of the deeper lias shale, with many layers of ironstone, resting upon more solid floors of the same strata. In these solid beds, the lowest probably which are exposed on the whole coast, we find the gryphæa incurva, which so generally accompanies the inferior beds of lias in the south of England.

Henceforward to the town of Robin Hood's Bay, the cliffs are composed of the deeper lias shale, in nearly level layers, surmounted by a variable covering of diluvial clay and pebbles. At low-water, the ranges of the strata are seen in grand curves sweeping across the whole extent of the bay. Beyond Baytown, the cliffs increase in altitude, and a rapid declination of the strata towards the north is observed for the space of three miles. In consequence of this the deep shale sinks into the sea at

little more than a mile from Baytown; the marlstone beds have all disappeared in about two miles, and from thence to Whitby the shore is kept by the upper lias shale. So great is the depression, that, between Hawsker bottoms and the place called High Whitby, the carbonaceous sandstones above the lias stoop very nearly to the water. The solid beds of sub-calcareous sandstone and ironstone, (which constitute the marlstone series), form prominent scars where they sink into the sea, and their blocks, which are scattered at the foot of the cliffs, may be advantageously examined for fossils. The highest point of the coast between Baytown and High Whitby, (two hundred and seventy-five feet,) is marked by the termination of the dogger series. This irony sandstone, though at Blue Wick on the south of Robin Hood's Bay it is so rich in fossils, does not here contain a single shell, and is very thin; but the sandstones which succeed above contain the same plants as at the Peak. To convey an accurate idea of the succession of strata above the lias, and beneath the cap sandstone, the following details, at points marked in the section, will be found sufficient.

At the point where a road leads down the cliff from Hawsker bottoms, we find the lias shale covered by fifty feet of sandstone, coal, shale, and dogger, arranged in the following order:

Strong slaty gritstone. Shale. Strong slaty gritstone. Shale. Slaty sandstone. Coal seam. Shale and gritstone, with marks of coal. Alternations of sandstone and shale. Irony bed or dogger. Upper shale, 100 feet.

At a point nearer High Whitby, the series of sandstones and shales is much more complicated; the following account was very carefully written on the spot.

	Ft.	*In.*
Loose blocks, sandstone, ironstone, shale, &c. ...	20	0
Coal	0	8
Grit, with vertical carbonaceous marks (coal pipes) ...	4	0
Irregular sandstone	5	0
Shale and ironstone	12	0
Sandstone	3	0

	Ft.	In.
Alternating shale and white sandstone bands ...	9	0
Sandstone	6	0
Shale and thin sandstones	8	0
Sandstone, slaty	2	6
Coal and irony knots with shale	10	0
White sandstone	2	0
Shale	6	0
Wedge-shaped grit rocks, from 20 to 30 feet.		
White sandstone and coal, with vertical pipe marks, from 5 to 20 feet.		
Shale	4	0
White sandstone	2	0
Shale	4	0
Layers of sandstone	3	0
Shale	12	0
Here a coal adit enters into the face of the cliff.		
White sandstone and plants	2	0
Irony or dogger bed	2	0
Alum shale	30	0

At a point called High Whitby, two hundred and eighty-five feet above high-water, the cap rock is upon the top, and ten or more alternations of shale and sandstones may be observed between it and the lias. A sandstone bed, seventy-four feet below the summit of the cliff, is remarkable for containing a great number of cylindrical fossil plants, jointed across like canes, or rather like equiseta, and furnished with a denticulated striated fringe or sheath at every joint. They are called by Mr. König, Oncylogonatum, by M. Brongniart, Equisetum columnare. They are situated vertically in the beds of sandstone, are broken off or imperfect above, and seldom reach to the upper surface of the bed; they are also broken off below, but commonly pass to the lower surface, and some of the lower joints nearest the roots are found in the subjacent bed of shale. These appearances have led some persons to conjecture that the plants are preserved in the place of their growth; that the shale served them for soil, and that they were buried by an influx of sand and water. A more probable hypothesis, perhaps, will suggest itself to those who have seen plants transported by great floods,

floating down the streams in a perpendicular position, in consequence of the superior specific gravity of their roots.

Proceeding from High Whitby, the cliffs fall gradually toward the north, and at the same time the lias rises to the height of one hundred feet above the sea. It however sinks again near the harbour at Whitby, where a great dislocation depresses it suddenly on the north, and prevents its distinct re-appearance as far as Sandsend. From High Whitby to this dislocation, though the sandstones and shales vary much in thickness and colours, we may notice that the thin coal seams are always most decisively marked, and most alluring to the adventurer, in the neighbourhood of the fossil plants which lie above the irony *dogger* bed. These plants consist wholly of what are believed to be monocotyledoneus tribes, like the zamiæ, or cycadeæ, and ferns of many genera. They lie in uneven, thin, white sandstones, alternating with black micaceous shale, and in ironstone, which is traversed by a white aluminous earth of the same nature as that previously noticed at White Nab, near Scarborough. A particular account of all these plants will be found in the latter part of this work. The dogger bed beneath them is a very singular layer of inconstant appearance, and varying substance. Sometimes, and indeed generally, it is a very irony nodular sandstone; but in other places, and particularly towards Whitby, it contains small pebbles of limestone, blende, small red ironstone, white felspar, porphyry enclosing glassy quartz, scoriform greenstone, red oxide of iron, &c. Towards the bottom, I have, in some places, seen it full of limestone pebbles, (lias ?) and under these a layer of large and small ironstone balls.

The upper lias shale may be well examined in the cliffs and on the scars, at low-water. Many remarkable and characteristic fossils may be here collected, especially the belemnites tubularis of Young, ammonites Mulgravius, &c., nucula ovum of Sowerby.

The great dislocation before mentioned, which depresses the strata on the north side of Whitby, extends a considerable distance up the valley of the Esk. Its effects are very remarkable at the sea side. On

the south side of Whitby harbour, a part of the cliff is composed of the upper alum shale, and this rock extends far into the sea, making broad level scars at low-water; but on the north side of the water is a cliff of sandstone, and a beach of sand. The exact amount of the depression occasioned by this fault cannot, perhaps, be determined; but I estimate it to be not less than one hundred and fifty feet.

Between the cliff which supports Whitby Abbey, one hundred and eighty feet above high-water, and that where the Lyth alum works are established, one hundred and ninety feet, the strata are depressed by the before-mentioned fault, so that the lias shale is almost wholly below the level of high-water, and the cliffs are composed of sandstone and shale, covered by a very abundant deposit of diluvial clay and pebbles. The highest point between Upgang and Whitby, is about thirty feet below the abbey, but generally the altitude is less than one hundred feet.

At Sandsend, the upper lias shale appears again in full character, about one hundred and fifty feet thick, under a covering of sandstone and shale beds, in the following order:

	Feet thick.
Irony sandstone rock	30
Shale	20
Dogger beds, consisting of irony sandstone in blocks ...	2
Parting of balls, or modules of ironstone	2
Rounded irony blocks	2

Where a small valley divides the cliff beyond the Lyth alum works, we observe rising from the water a portion of the shale, apparently more compact than the rest, and bearing much better the action of the sea. It is consequently much scooped into caves and fantastic projections, which are never seen in the softer shale above and below. On the cliff top, the sandstone cap ranges uninterruptedly to Kettleness alum works; and in the highest point is not less than three hundred and seventy-one feet about high-water. Here the sandstone, shale, and dogger, above the lias, are together one hundred feet thick.

At Kettleness, from the sandstone rock just above the alum works to the lias scars beneath, we have the following section:

		Feet.
Carboniferous series.	Cap sandstone nearly	50
	Sandstone traversed by ochry veins ...	4
	Shale	
	Irony stone, in nodular masses and beds ...	
Lias series.	Upper lias shale or mine	150
	Hard shale, with layers of calcareous nodules ...	30
	Soft alum shale	20
	Alternations of ironstone beds and alum shale, forming projecting scars	20

These ranges are seen on the other side of the point, dipping partly along the shore, so that in the extremity of Runswick bay the hard shale descends to the level of high-water mark, and forms the well-known arched rocks. Here the soft shale is almost deficient,, so that the ironstone courses appear almost immediately in contact with the hard shale. From the arched rocks to the village of Runswick, the low and broken cliffs are wholly composed of diluvial clay and pebbles.

Above the romantically placed village of Runswick, the cliff is about two hundred and fifty feet high, and the sandstone cap is seen upon the upper lias shale. The little valley or gully which is here scooped in the steep descent, exhibits imperfect but, I think, satisfactory traces of a fault or dislocation, the strata being higher on the north side by about forty feet. From hence to a higher situation, called, I believe, the Old nab, marked by two tumuli, the range of the sandstone is unbroken, but it is variously divided by interposed shale. At nearly a mile beyond Runswick there is a projecting point, and beyond it a wide bay. This point I think is three hundred feet high, and it exhibits, below a slight covering of diluvial matter, more than one hundred feet of sandstones, shales, and irony dogger above the upper lias shale, which is about one hundred and fifty feet thick, besides the hard rocky beds which are exposed to the attacks of the sea. The bay beyond is over-

hung by a broken slipped cliff, whose extreme height is about three hundred and twenty feet. The hard beds of shale continue to guard the shore. The tumuli beyond this bay appear to be three hundred and twenty-one feet, above high-water, whilst the cliff itself is three hundred and one feet, and the thickness of the sandstone series above the lias seventy-three feet. The upper lias shale seems to be one hundred and ninety feet thick, and the hard shale below about forty feet thick.

From this place the sandstone rocks pass inland; and the other strata rise successively toward Staithes. The hard shale forsakes the base, and ascends to the summit of the cliff at the signal post, whilst from beneath it, first the soft shale appears, and afterwards the ironstone courses, in the same order as at Kettleness. A little bay not far from the tumuli exhibits a very pleasing scene at low-water. For then the ironstone courses, which there spread out from the cliff, are visible over a wide extent, in a series of elegant flexures corresponding to slight variations of their declination. They contain multitudes of terebratulæ, pectines, belemnites, wood, &c. Beyond, they rise into the cliff, and may be traced towards Staithes, till their regularity is suddenly broken by an oblique dislocation, which causes a depression, on the north side, of fifteen feet. The section here exhibited consists, under the diluvial covering, of hard shale, soft shale, and ironstone beds, and the extent of the dislocation may be accurately determined.

On arriving at Staithes, a much greater dislocation demands our attention. The cliffs on the opposite sides of this harbour display fine sections of strata; and it is with surprise we perceive that they are quite dissimilar. The signal cliff on the east has a diluvial covering, and beneath it hard shale, irony, and rugged, with great balls of ironstone; soft shale, with a remarkable sulphureous line in it; and the ironstone series, consisting of layers of ironstone nodules and beds, alternating with shale. But in Colborn nab, on the west side, we find a diluvial covering, and beneath it a series of alternations of shaly and sandy beds, in some of which is an indescribable profusion of fossils, especially cardium trunca-

tum, pectines, and dentalia; and at the bottom the deeper lias shale, with a few layers of ironstone nodules. The extent of this dislocation is obviously something greater than the whole height of Colborn nab; for all the strata which it exhibits are naturally placed below the lowest of those in the signal cliff; they are therefore elevated about one hundred and fifty feet higher on the west than on the east side of the harbour.

This being a place where the ironstone and marlstone series is seen to great advantage, I have drawn an enlarged section of the opposite cliffs, which should be connected with the following reference:

x. Diluvial clay and pebbles lying on the top of the cliffs, on both sides of the harbour.

In the cliff on the east side occur the following beds:

a. Hard shale, irony and rugged, with great balls of ironstone.
b. Soft shale, with a remarkable sulphureous line in it.
c. Ironstone series; consisting of layers of ironstone nodules alternating with shale. Pectines, terebratulæ, belemnites, and wood, are abundant in this group.

Colborn nab cliff, on the west side of the harbour, contains strata which in other places on the coast are seen to lie beneath *a, b, c,* though in consequence of the great dislocation they here front them on a level.

d. Alternations of shale, and thin, soft, sandy beds.
e. Alternations, mostly consisting of sandstone.
f. Sandstone and shale, with numerous fossils.
g. The lower alum shale, with layers of ironstone.

The dislocation at Staithes is the last which I shall have occasion to notice. For though the declination of the strata in the lofty cliffs beyond is variable and subject to flexures, there is no fault or break whatever. Another general fact is, that the deeper shale, which shewed itself at the foot of Colborn nab, is uniformly found in the lowest parts of the cliff, from that point to Saltburn. It rises from Colborn nab towards the precipices of Boulby, and there attains an elevation of about

one hundred feet. It encloses nodules of ironstone in rather distant layers, and many fossils, as belemnites, plicatulæ, pectines, gryphææ, wood, &c.: from this height it sinks down to almost the level of the sea, at the Lofthouse boiling-houses, and so continues across the bay at Skinningrave, but further on it ascends, and in the loftiest point of Huntcliff seems to be one hundred and eighty feet above high-water. It falls again towards Saltburn, and terminates against the diluvial cliffs there at an altitude of about fifty feet. It appears, then, that nowhere on this part of the coast is the lower shale disclosed in greater thickness than two hundred feet, whereas, in consequence of the great fault at the Peak, three hundred feet are there seen in the cliff. Toward Staithes the low-water scars of this shale are rendered interesting by the singular appearance of the sandstone and ironstone masses, which look like mushrooms on little pedicles of shale. They have evidently protected the shale beneath them from wasting.

The sandy conchiferous marlstone beds, which in Colborn nab cover the lower lias shale, are seen rising with it, and contributing to swell the altitude of Boulby and Rockcliff. The lower part of this series is generally the most solid, and projects in broad compact floors above the lias. On the surfaces of such beds lie innumerable multitudes of oysters, dentalia, pectens, cardium truncatum, avicula inæquivalvis, and, more rarely, about Staithes, * beautiful fossil star-fishes of the genus ophiura. The marlstone may be well examined on the shore from the boiling-houses of the Rockcliff works to Skinningrave, for there the beds come near to the level of the sea. But along the whole coast fallen masses of this rock abound, and will richly reward the researches of the industrious collector. Above lie the ironstone courses which were noticed on the side of Staithes harbour. These range uninterruptedly across the front of Boulby and Rockcliff, and again shew themselves in the highest part of Huntcliff. Still higher in Boulby and Rockcliff, we trace the soft shales and hard shales with limestone nodules, which were observed

* Mr. Miller, of Bristol, informs me that fossil specimens of ophiura have been found in the lias at Fretherne, in Gloucestershire

at Kettleness and near Staithes; on these lies the great bed of aluminous shale, which is so extensively worked, and the whole is surmounted by the sandstone cap rock.

In Boulby cliffs, then, we have the whole series of lias beds exposed, and are thus enabled to groupe the minuter parts of the formation into convenient natural divisions, and to apply these to complete other less perfect sections.

The following statement, referring by figures and letters to the general and enlarged section, presents a summary view of the whole lias formation visible in the northern cliffs.

15. Upper lias shale in three divisions:

a. Alum shale, mostly of a dark colour, and smooth equal texture, fissile into thin laminæ, very sulphureous, and rich in ammonites, belemnites, nuculæ, amuphidesmæ, unioniform shells, &c. It is exclusively employed for the manufacture of alum, and varies in thickness from one hundred and forty to one hundred and eighty feet.

b. Hard lias shale, much less fissile than the above, containing nodules and lenticular masses of argillaceous limestone, sometimes coated by pyrites. This is occasionally very irony, and, in consequence, much discoloured: twenty to thirty feet. It projects like a solid rock along the breast of the cliffs, and is excavated into caverns at their base.

c. Softer layers of alum shale similar to 15 *a*, with a few courses of ironstone balls, and a remarkable line of sulphureous shale in the middle: twenty to forty feet.

16. Ironstone and marlstone series, consisting of

a. The ironstone bands, which are numerous layers of firmly-connected nodules of ironstone, often septariate, and enclosing coniferous wood, pectines, aviculæ, terebratulæ, &c.: twenty to forty feet.

b. The marlstone series, consisting of alternations of sandy lias shale, and sandstones, which are frequently calcareous, and generally full of shells. The

lower beds are usually most solid, and project from the cliffs in broad floors, covered with pectines, cardia, dentalia, aviculæ, gryphææ, &c. Thickness variable, from forty to one hundred and twenty feet.

17. Lower lias shale, more solid, less fissile, and generally of coarser and more sandy texture than 15, with a different suite of organic remains, amongst which plicatulæ, gryphææ, and pinnæ are, perhaps, most characteristic. Thickness exposed in Huntcliff less than two hundred feet, at the Peak three hundred feet, but the bottom is nowhere seen.

Huntcliff has the advantage of shewing a greater thickness of the lower shale than Rockcliff, but its series is very incomplete above; the upper shale having retired inland beneath the beacon. There is hardly any diluvial matter observable on the high summits of Rockcliff, but it occupies a large portion of the lower cliffs near Skinningrave; is in considerable quantity on Huntcliff; and gradually thickens toward Saltburn, till at length the lias formation is abruptly truncated, and the whole cliff is diluvial. Henceforward to the Tees no regular stratum appears in any cliff beneath the diluvium, but at low-water, opposite Redcar, the lower shale with characteristic fossils stands up in bare hard rocks.

Having thus brought to a close the descriptions of the strata of the Yorkshire coast, it remains to add a few remarks on the composition of the diluvial accumulation which is visible on so many of the cliffs between Bridlington and the mouth of the Tees. These remarks, if introduced in detached portions amongst the descriptions of the solid strata, would have been much less intelligible than when brought into one point of view.

As in Holderness and at Flamborough, so in the more northern cliffs, the most abundant of the diluvial accumulations is a mass of clay unequally filled with a variety of pebbles, and occasionally divided by partial deposits of sand and gravel. These are the materials heaped in

such profusion along the shores of Filey bay, Cayton bay, Carnelian bay, and the south and north cliffs of Scarborough, as well as in the retiring cliffs of Robin Hood's bay, Upgang, Runswick bay, Skinningrave bay, and the long range of coast west of Saltburn. Nor, though most plentiful in the hollows of the coast, is it unknown on the heights, for it occupies the very highest precipice of chalk, four hundred and thirty feet above the sea, lies in abundance on Gristhorpe, and covers the summit of Huntcliff.

To give a complete catalogue of all the varieties of pebbles which lie in this clay, would be a work of great labour and little interest. Such comparisons are important only in proportion to the light they throw on the probable direction in which the waters moved, that transported them to their present localities; and this object is better attained by selecting a few well-defined rocks, than by gathering loads of ordinary specimens. We find mixed up in this diluvial clay, fragments of rocks belonging to the granitic and slate series, as well as to the independent and secondary formations; and it is often possible to determine the districts, and even the particular hills from which they have been drifted. Thus we trace back to Shap fell its porphyritic granite; to Carrock fell its sienite and greenstone; to the Grasmere mountains their amygdaloidal and brecciated grauwacke; to Kirby Stephen its calcareous breccia; to Teesdale its greenstone; and to Western Yorkshire its limestone, sandstone, and coal. But it is from Durham that we have derived the concretionary limestone of Building hill, and we must seek in Scotland, and perhaps Norway, for the original sites of our garnet slate, porphyries, amygdaloids, hornblende, diallage, and hypersthene, and a still greater distance has been travelled over by the fragments of Labrador felspar. Generally speaking, we may say the waters, which brought together the heterogeneous mass of diluvium which loads the coast of Yorkshire, flowed from various points of the compass between N. and W.

Besides these effects of diluvial streams flowing from great distances, we trace the results of less extensive currents. The wasted cliffs of Robin Hood's Bay have probably furnished the numerous lias and marl-

stone fossils which abound near the spaw at Scarborough, and in the cliffs of Holderness; sandstones from the neighbouring moors lie on the cliffs between Scalby and Cloughton Wyke; and the chalk rocks of Flamborough have been scattered in fragments through the clay cliffs from Bridlington to Hornsea. The remarks on page 21, as to the comparative degree of attrition of the boulders, are applicable to the whole coast of Yorkshire. The largest masses are always observed to be granite, mica slate, greenstone, or mountain limestone. Of these large fragments, which have fallen from the ruined cliffs, may be seen at intervals near the low-water mark, opposite Dimlington height, under the Danish dyke, on the summit of the beacon cliff at Flamborough, on the shores of Filey, Scarborough, Robin Hood's Bay, Skinningrave, and Saltburn. It is not even uncommon to see many such boulders together, each weighing perhaps a ton.

It is difficult to assign the native repositories of the beautiful agates, heliotropes, and jaspers, which are found on the shores of Holderness, Speeton, and Scarborough, after the wintry storms have caused the fall of some portions of the diluvial cliffs. They are probably all productions of trap rocks, possibly derived from the hill of Kinnoul and other amygdaloidal basalts of Scotland. The question as to the nature of the beautiful dendrizations in moss agate remains unsettled; for Dr. M'Culloch's ingenious chemical experiments leave doubts on their vegetable origin, which botanical investigation has not removed. Jet, another interesting product of this diluvium, may be traced to the neighbourhood of Lyth, where considerable masses of it have been obtained from the cliffs of alum shale. It also occurs in other parts of the lias series, rather frequently in the lower shale near Skinningrave, generally in connexion with fossil wood, of which it forms the external layers. Seams of it also divide sandstone blocks in Hawsker bottoms. Magnetic sand (oxydulated titaniferous iron) occurs in great plenty on the shore where diluvial cliffs are exposed to rapid waste, or their disintegrated materials are retained in some sheltered bay. It is particularly abundant at Scarborough and near Hilston in Holderness.

Teeth and tusks of the mammoth are almost the only remains of quadrupeds, which I remember to have been found in the diluvium of this coast, and these have been obtained at several points near Hornsea, Bridlington, Scarborough, and Robin Hood's Bay. Remains of the same kind, with or without bones and teeth of oxen, deer, and horses, have been found in gravel pits at Brandsburton, Hessle, and in the vale of York. Upon the whole, therefore, the diluvium in the eastern part of Yorkshire possesses the general characters of that deposit, and agrees, in a particular manner, with the accumulations of the same æra which have been so long known and so well examined in the eastern part of Norfolk.

A summary account of the animal remains found in Kirkdale cave, and in the equally remarkable repository of antediluvian quadrupeds, at Northcliff, will be found in a subsequent part of the volume.

CHAPTER III.

Organic Remains of the Eastern Part of Yorkshire.

THAT vegetable and animal remains should be enclosed in hard rocks, in prodigious abundance and of exquisite beauty, has been a subject of admiration from very early periods. The difficulty of conceiving how the rocks could be so softened and dissolved by the deluge, (to which all geological phenomena were attributed in the 17th century,) as to admit shells and plants into their substance, induced Plot and Llwyd, and even Ray and Lister, to deny that these fossil bodies had ever been living beings. This absurdity gradually yielded to the talent and industry of Woodward; and is remembered only to be ridiculed. It is now universally admitted by naturalists that fossils are the reliquiæ of beings once endowed with life; and that all the difference in appearance, between them and analogous recent objects, has been caused by circumstances attendant on their long sepulture in the earth.

The earth contains reliques of perhaps the most ancient plants and animals which existed on this globe, and they lie enclosed in rocks of different chemical composition, at various depths and of unequal antiquity. According to their original qualities, and the circumstances in which they were placed, fossils have undergone different changes of substance.

Few organic bodies are preserved in the earth, except such as were originally of a durable constitution. Remains of plants are common in coal districts, wood is found in many limestone rocks, nuts and hard fruits have been obtained from the Isle of Sheppey; zoophytes of many kinds fill our limestone and sandstone rocks; thus the horny substance of spongiæ, and the calcareous mass of corals is accurately preserved; the columns of crinoidal animals, and the hard crusts of echini are very

plentiful; shells are innumerable; the crusts of lobsters and crabs, and the scales of fishes are scarce, but teeth and vertebræ of the latter are more abundant; aquatic reptiles have left us their bones. Now all these were originally durable; they are all capable of conservation in our cabinets: but the softer animal substances once connected to them, have entirely disappeared. Even the ligament which is placed at the hinge of bivalves to open the shell, is most rarely preserved in a fossil condition. Considerations of this nature render it extremely probable, that the process of mineralization, or (as it is commonly called) petrifaction, was slow and gradual.

Another general remark must be made to prevent misconception. Fossils are at some places found perfect, at other places in fragments. Now they must have been enveloped in these conditions respectively. From carefully observing these appearances, we may form pretty clear notions as to the tranquillity or agitation of the fluid in which they were deposited. In general, substances originally bound together by perishable ligaments are found in detached pieces, owing to the decay of those parts previous to their being enclosed in the rocks. Thus the shells of crabs and lobsters are commonly disintegrated, bivalves are often separated and vertebræ and teeth of fishes scattered far asunder in the rock. Such instances as these occur daily in our streams and on the sea-coast, and, therefore, in former periods may have happened without any particular agitation of the waters.

Some beds of shells, as the forest marble of the neighbourhood of Bath, appear to have been accumulated with violence and confusion: but generally the sharpness of their angles and perfection of their ornaments lead to the conclusion that they were quietly entombed near the spots where they lived.* The vegetable fossils are, however, a remarkable exception to this, and, being almost always in fragments, seem to

* Consult the Prefaces of Mr. Smith's works, Strata identified by Organized Fossils, and Stratigraphical System of Organized Fossils; and Cuvier's Theory of the Earth, for illustrations on this point.

point out a general turbulence in the waters at the period of their deposition. I must not go further into the cause of this exception, than to state, that if, as is believed, nearly all these vegetables grew on land, and were thence transported to the sea, they would naturally be broken to pieces by that operation.

The chemical changes which fossil plants have undergone are various, and seem partly to depend on peculiarities in their original structure, and party on the nature of the strata which enclose them. Thus the fibrous wood of dicotyledonous plants, found in the limestone of Malton, appears as a brown carbonaceous mass, much traversed by calcareous spar: that which lies in the calcareous gritstone beneath is sometimes impregnated with siliceous matter; but in the aluminous shale of Whitby such wood is party converted to jet, and partly filled with pyrites, or calcareous spar. The ferns, and other monocotyledonous plants, which lie in the sandstones and shales of our coal districts, are very differently preserved. Whatever be the kind of plant which is found in shale or fine-grained gritstone, all that remains of its substance is coal, often of the purest and most inflammable quality. In this case we may suppose the decomposition of the vegetable matter to have been slow and gradual; and being performed under a close covering of shale or gritstone, the resulting chemical substances were prevented from escaping, and made to combine into a new inorganic compound,—coal. The same plants lying in coarse sandstone retain very little of their original substance, perhaps on account of the porosity of the rock, which might both favour the decomposition of the plant, and hasten the escape of the resulting gases, and soluble matter.

After investigating the changes which have happened to fossil plants, no reasonable doubt can be entertained as to the vegetable origin of all our beds of coal. Perhaps the different qualities of coal may be in a great degree owing to the nature of the constituent plants.

The hard parts of invertebral animals, which are preserved in the earth, are closely allied to each other in chemical composition. In all

of them, glutinous or gelatinous matter forms the base, and is more or less hardened by admixture with carbonate of lime. Soft corallines, echini, and the coverings of crustaceous animals, contain likewise some phosphate of lime, but generally in small quantity. Four principal states of preservation may be distinctly observed among these fossils.

First, when the coralline or shell retains not only its external figure and appearance, but even its internal texture and almost all its original substance. Such specimens look as if obtained from the sea in a dead state, with no other loss than that of colour and brilliancy. This perfect state of preservation is well exemplified in the beautiful fossils which lie in the comparatively recent strata near London and Paris. The fossil shells of Specton on the Yorkshire coast are very little altered except by the loss of their gelatinous matter, which causes them to be of a chalky or friable consistence.

In the second condition of fossil shells and corallines, the figure and general appearance are little or not at all altered, but the composition is completely changed by the insinuation of extraneous matter: thus the calcareous substance of shells and corals, and the horny fibres of sponge, are become flint. In such cases the new substance appears to have been introduced gradually, so as to fill the pores of the perishing original body. The same explanation probably applies to the petrifaction of wood.

The third condition is exemplified by those stony masses, frequently found in limestone quarries, which have the general figure of shells, but not their structure nor texture. These are casts or moulds in the cavities of shells, which have been dissolved and carried away from the places they once occupied in the rock. In consequence, the cavity left retains the exact impression of the outside of the shell, and encloses a stony mass which was moulded within it. The same explanation applies to the flint moulds in the cavities of echini, and to the 'screw-stones' which are casts in the central hollow of crinoidal columns.

The fourth condition of fossil shells, &c. is produced by a process in addition to that just described. The cavity left by the removal of the shell is, in this instance, filled again by crystals of carbonate of lime, introduced by water filtrating through the stone. When this process is but partially executed, the cavity is imperfectly lined with crystals, but when it is completed, the new substance takes exactly the form of the original shell, but displays no trace whatever of its internal structure. In the Yorkshire oolites, the thick shells of trigonia and gervillia exhibit this metamorphosis in a very striking manner.

That the peculiarities in the conservation of fossil shells and analogons reliquiæ, depend much on the original nature of the bodies, is evident from the following well-known facts; the shells and spines of echini, and the columns of crinoidea are almost invariably converted to a peculiar kind of calcareous spar, in whatever strata they may be found; so the belemnite is always known by its radiated structure, and the gryphite has retained its original laminæ. But the nature of the imbedding substance is also of great consequence in the inquiry. Shells which lie in the green sand are generally converted to flint; those which lie in oolite are often changed to calcareous spar; but those which lie buried in clay seldom exhibit either of these characters.

The interesting subject of the conservation of fossils might be extended to great length; but as these explanations were introduced chiefly to facilitate the understanding of terms which will afterwards be employed, there is room only for another observation on the bones and teeth of vertebral animals, which are principally composed of phosphate of lime, united by a cartilaginous substance. Remains of this kind being much fewer than those of the preceding tribes, do not afford so great a variety of mineral appearances. On the contrary, their state of preservation is remarkably uniform, under whatever circumstances they are found. Fish teeth, for example, are always recognized by a peculiar polish and hardness, and are commonly of a black colour (except in chalk.) They retain the whole of their phosphate of lime, but part of the animal substance is generally replaced by an additional quantity of carbonate of

lime which accounts for their high specific gravity. Bones of fishes and aquatic reptiles retain their cariose texture, and frequently their original composition.

DISTRIBUTION OF FOSSILS.

Modern naturalists have discovered in the earth the remains of several hundred different plants, and several thousand kinds of animals. The peculiarities of form and structure among fossils are as constant and defined as among the living productions of nature, and the species are often as well distinguished. Upon comparing them with existing races, it is discovered that they are generally quite distinct; so that the fossil tribes, in some degree, appear like a separate creation, and have been elegantly termed "organic remains of a former world." But, though different in detail, the ancient and existing races of organic nature are alike in generalities, and analogous in essential points of structure; and forcibly urge us to conclude that they were destined for similar modes of life. In the present economy of nature, plants of particular structure are appointed to exist under particular circumstances; shells of certain forms are peculiar to water, and others belong to animals which live habitually on land; and, generally, so constant is the agreement in the structure and functions of organic beings, that from the one we may infer the other. Who, that views the striking general resemblance of fossil and recent bodies, and considers the similar accidents to which both have been exposed, can hesitate for a moment to admit that conclusions drawn from examination of the structure of fossils, are as valid as those which are inferred from recent examples. The principle of investigation is in both cases the same, viz. the inevitable accordance between the construction of the creature, and the uses for which it was created.

From examinations conducted on this principle, it is inferred that the secondary strata contain remains of marine, lacustrine, and terrestrial

plants; of marine and fresh-water shells, crustacea, and fishes; and of aquatic and terrestrial reptiles, mammalia, and birds. This simple statement furnishes ground for most interesting deductions respecting the ancient condition of the globe. We cannot, indeed, determine what was the comparative extent of its seas, lakes, and dry land, but we may form very reasonable opinions concerning its temperature, and a tolerable history of its inhabitants at different periods. For as the order of successive position among the rocks is likewise that of their relative antiquity, the fossils collected from these rocks may be arranged in chronological order.

The fossils of Britain thus arranged, (according to the example of Mr. W. Smith,) present us with many curious and important results. The following instances are selected rather to shew the richness and beauty of the subject, than to include all that is known respecting it.

The organic reliquiæ of marine animals are, perhaps, more ancient than those of plants, for they lie in the slate rocks of Cornwall and North Wales, whilst no plants have yet been found in any rocks so low in the slate series. The most abundant fossil remains of plants belong to terrestrial tribes; but the animal reliquiæ are mostly of aquatic origin; and very few examples are known of any bones of terrestrial animals occurring in strata more ancient than those above the chalk.

The most ancient animal remains are those of bivalve shells, (spiriferæ,) such as are not known to exist at present. The most ancient fossil plants, which appear in the lower carboniferous and in the transition rocks, almost wholly belong to terrestrial genera of the natural monocotyledonous orders, filices, lycopodiaceæ, and equisetaceæ, and, by their analogy to existing tropical tribes, seem to demonstrate that the climate of these northern regions was then warmer than it is at present.

The fossil plants of the middle æra, which accompany the lias and oolitic rocks in Yorkshire and Sutherland, belong chiefly to the natural

monocotyledonous orders, filices, lycopodiaceæ, equisetaceæ, and cycadeæ, but fragments of dicotyledonous plants also occur with them.

The least ancient group of fossil plants, which are enclosed in strata above the chalk, are a mingled suite of monocotyledonous and dicotyledonous tribes, both terrestrial and lacustrine, bearing considerable analogy to plants now in existence. The greater number of fossil shells are certainly marine, but those which lie in layers amidst the monocotyledonous plants of the carboniferous formation, belong almost wholly to fresh-water genera, now in existence. Other local aggregations of fresh-water shells occur in the upper part of the oolitic series of rocks; but a general deposit of this kind occurs among the most recent, and contains species very similar to those that now exist.

The greater portion of the most ancient fossil shells, &c. belong to genera now extinct, as the productæ, spiriferæ, pentameri, orthoceratites, trilobites, and many genera of crinoidea; and on the other hand, the least ancient of the fossils, though specifically distinct from existing races, are mostly included in the same genera.

But the most important results to geology, arising from the contemplation of organic remains, are founded on a minute scrutiny of their specific characters, and a careful register of their localities in the strata. It is not enough for the rigid accuracy of modern inquiry, to say that a given rock contains corals, shells, and bones of fishes; but we must know the particular species, and determine all the circumstances of their occurrence. The more exact and extended our researches on this subject become, the more clear will be our statements on the succession of created beings, the more certain our applications of zoological principles to determine the relative antiquity of rocks, and the more satisfactory our views of the formation of the strata. Works which, like the present, profess to describe the rocks and fossils of a particular district, lose a large portion of their utility if they are composed without reference to general principles. It is in such local catalogues that the

man of enlarged views in geology ought to find the best evidence of important truths, and the means of correcting serious errors. For these important ends, it is necessary that every known locality in the strata should be recorded of every fossil. For want of this precaution, fossils have been often stated to be characteristic of a particular rock, when in fact they occur in several others; and thus a crowd of errors has been introduced, which have obscured the truths taught by Mr. Smith, and given occasion for denying that a comparison of their imbedded fossils is useful in identifying and discriminating the strata. Deeply impressed with the interest and importance of this subject, I have sought the means of placing it in a clear and correct light; and am not without hopes, that whether my views be received or rejected, my statements will be found unprejudiced, and, though incomplete, correct.

I shall now endeavour to investigate some of the general laws, respecting the relation of fossils to the strata, which are either already recognised and admitted among geologists, or unfolded in the following pages. The inquiry naturally divides itself into two parts, according as the strata are considered, with respect to their chemical and mineralogical composition, or their relative antiquity. Considering rocks as definite chemical compounds, (an assumption sufficiently exact in a limited district,) we may inquire if fossils of the same kind belong to strata of the same character.

A decisive answer in the affirmative will suggest itself to him who observes the agreement in this respect, between the transition limestone and the mountain limestone, in their bivalve shells and trilobites, between this latter rock and the oolites in their astreæ, turbinoliæ, and milleporæ, and between the oolites and the chalk, in some of their echini and terebratulæ. But this analogy vanishes altogether when we attempt to extend it to a considerable series of fossils; no other strata than the limestones exhibit it in a striking degree, and few tribes of organic remains can be quoted in illustration except the polyparia and radiaria. On the contrary, the shells of the mountain limestone, oolite, and chalk, are all

entirely distinct from one another, and immediately suggest the second inquiry, to which we now proceed. What is the relation between the species of fossils, and the antiquity of their enveloping strata? That such a connexion between the age of a rock and its organic contents does certainly exist, and may plainly be recognised, will appear from a few facts which any one may verify by examining a good collection of Yorkshire fossils, or a sufficient suite of specimens from the same strata in other parts of England. The mountain limestone of the north-western dales of Yorkshire, abounds with crinoidea, productæ, spiriferæ, and bellerophontes, of which no single individual has ever been found in the strata of the eastern part of the county, which on the other hand, contain echini, trigoniæ, cucullææ, rostellariæ, and ammonites, to which there is nothing similar in the west. The partition between these groups of strata and their fossils is made by the red sandstone stratum, which, in Yorkshire at least, has never yielded one single organic fossil. The same observation has been made in other parts of England. Again, in the eastern part of Yorkshire itself, a complete partition of the same kind is made by the blue clays of the vale of Pickering, between the chalk on the south and the oolitic rocks on the north; both full of fossils, and those entirely different.

I am sure that these assertions will not be disputed by any person at all acquainted with geological phenomena, or accustomed to distinguish the characters of fossils. The consequence flowing from them is of the highest importance and interest; for, since it thus appears that a few shells brought from a quarry are data sufficient to determine the geological relations of the rock, we are entitled to conclude, that in a given district the age and position of certain strata, or groups of strata, are infallibly indicated by their organic contents. These researches, commenced by Mr. Smith in England, have been extended with the same results over all parts of Europe, and a large portion of America, and therefore it is concluded that strata, or groups of strata, are to be discriminated in local regions, and identified in distant countries, by their imbedded organic remains.

Having thus obtained the general principle, let us endeavour to ascertain the extent of its applicability, and the precautions necessary to ensure accurate results.

So unequally are the different species of fossils distributed in the earth, that, whilst some are dispersed through several neighbouring strata, as clypeus clunicularis among the oolitic rocks, others are confined to one stratum, as ammonites calloviensis to the Kelloways rock, and some to a particular bed of stone, as the astreæ which characterise the coralline oolite.

It is, therefore, possible, by collecting numerous specimens procured from a limited district, to assign to each formation of strata, single stratum, or even characteristic bed of stone, all the fossils which have ever been discovered in it. Such catalogues being compared, formations, strata, and beds, may be found to differ from one another by the presence or absence of particular species. A given formation may possess species never found in any of those above, and it may be deficient in others which do occur above; and in like manner it may differ from those below. Hence it may be concluded,

1. That a formation or stratum may differ from all those above it, by the presence or absence of certain species, and from all those below it, by the presence or absence of other species:

2. That it may contain some particular species, unknown either above or below. We may add, that formations and strata may differ by the relative abundance or paucity of their imbedded fossils.

EXAMPLES.

1. The coralline oolite formation, as defined p. 1, appears to me to differ from all the formations above, by the presence of ammonites perarmatus, mya literata, and clypeus clunicularis, and by the absence of ostrea delta, hamites, and ananchytes; and from all those below, by the

presence of spatangus ovalis, and ammonites perarmatus, and the absence of productæ, axini, ammonites Walcottii, nerita costata, astarte minima, and terebratula digona.

2. Again, the Kelloways rock differs from all the strata above it and below it, by the presence of ammonites calloviensis, and gryphæa dilatata: no stratum in Yorkshire but the Kimmeridge clay contains ostrea deltoïdea; nor is gryphæa incurva found except in lias beds or lias boulders.

3. It is in the lower part of the coralline oolite that clypeus dimidiatus, and c. clunicularis abound, but melania striata belongs to the upper layers of that rock.

These are the principles of investigation which it is proposed to apply to the strata and fossils of the eastern part of Yorkshire, and to illustrate by the aid of the arranged catalogues which follow, and their accompanying plates.

I shall first present complete lists for each stratum, of all the fossils found in it, distinguishing those which are repeated in other strata, and referring to figures contained in this work, Mr. Sowerby's Mineral Conchology, Mr. Smith's Works, Mantell's Geology of Sussex, Young and Bird's Survey of the Yorkshire Coast, Kendall's Catalogue of Scarborough Minerals and Fossils, Parkinson's Organic Remains, &c.

After thus unfolding the evidence which I have collected on the subject, I shall venture to propose some inferences concerning the distribution of organic remains in the rocks of the country which I have undertaken to describe, and likewise endeavour to trace the extent of the agreement in this respect, between the strata of Yorkshire and those of Scotland, the southern counties of England, and some parts of the continent.

Lastly, I propose to combine the whole into one synoptic list of the organic remains mentioned in this work, arranged in the ascending order

of their natural affinities; accompanied by references to their place in the scale of stratification. As a considerable portion of the fossils herein mentioned have not been previously described or figured, it has become necessary to assign names to them. In the execution of this duty, manuscript names, when attainable, have been generally adopted, and, instead of specific characters, a figure, of the natural size, or in the proportion expressed by the contiguous fractions, is given to illustrate every new species. New figures have sometimes been added of fossils but little known, highly important, or not before represented with proper fidelity; but this has been seldom judged necessary with respect to common species, for which a reference will be found to some generally known and accessible work on the subject.

FOSSILS OF THE WHITE CHALK.

ZOOPHYTA.

Spongia……(Alcyonium of authors. Ventriculites, &c. Mantell)

* *fungiform species.*				
1. plana	… … …	Pl. I. fig. 1.		Dane's Dike, Bridlington.
2. capitata	… … …	fig. 2.	…	Ditto.
3. (like 2, but with a rounded edge)				Ditto.
4. osculifera	… … …	fig. 3.	…	Ditto.
5. Benettiæ (Ventriculites, Mantell)	…	fig. 4.	…	Ditto.
6. verrucifera (a species with large internal verrucæ)				Ditto.
7. convoluta	… … …	fig. 6.	…	Ditto.
8. marginata	… … …	fig. 5.	…	Ditto.
* * *fistuliform species.*				
9. radiciformis	… … …	fig. 9.	…	Ditto.
10. terebrata	… … …	fig. 10.	…	Ditto, &c.
* * * *funnel-shaped species.*				
11. porosa (or a variety of S. alcyonoïdes?)		fig. 8.	…	Ditto.
12. lævis, the surface without reticulated meshes, magnified views of portions are given	… … …	fig. 8 *a*.	…	Ditto.
13. alcyonoïdes (Smith, fig. 1.)	…		…	Ditto & Brantingham.
14. cribrosa	… … …	fig. 7.	…	Dane's Dike.
* * * * *ramose species.*				
15. ramosa? (Mantell, Pl. XV. fig. 11.)		…	…	Ditto.

Lunulites urceolata, Lam.	It is doubtful whether these be really distinct.	Pl. I. fig. 11.	Dane's Dike.
Millepora ? globularis		fig. 12.	Ditto.
Caryophyllia centralis (Mantell) ...		fig. 13.	Ditto.
A species of cellepora attached to Spatangus hemisphæricus			Knapton.

RADIARIA.

Apiocrinus ellipticus (Miller's Crinoïdea)		Dane's Dike.
Marsupites ornatus (Miller)	Pl. I. fig. 14.	Ditto.
Echinus Konigii (with its spines attached)		Ditto.
Cidaris papillata (Park., &c.) a single plate ...	fig. 14 *a*	Ditto.
Galerites.—1. albogalerus (Org. Rem. Pl. II. f. 10.) ...		Hessle.
2. subtrotundus (Mant. xvii. fig. 15.) ...		Dane's Dike.
Ananchytes.—1. ovatus (Smith, Strat. ident. fig. 10.) ...		Dane's Dike, &c.
2. hemisphæricus (Cuv. et Brong. v. fig. 8.)		Dane's Dike.
3. intumescens (with five swellings round the vent)		Ditto.
Spatangus.—1. cor anguinum (Cuv. et Brongn. iv. fig. 11.)		Dane's Dike, &c.
2. planus, (Mantell) ...	Pl. I. fig. 15.	Dane's Dike.
3. hemisphæricus ...	fig. 16.	Knapton and Dane's Dike.

MOLLUSCA.

Inoceramus.—1. Cuvieri (Min. Conch. tab. ccccxli.)	Hunmanby, Etton, Hessle, Cottingham, &c.
2. Brongniarti ? (Min. Conch. tab. ccccxli.)	Hunmanby.
3. cranium, a large smooth species ...	Ditto.
Terebratula.—1. subundata (Min. Conch. tab. 15.)	Dane's Dike.
2. semiglobosa (Min. Conch. tab. 15.)	Ditto.
3. pentagonalis ... Pl. I. fig. 17.	Ditto.
4. subplicata (Mantell, xxvi. 5, 6.) ...	Dane's Dike, Etton.
Dianchora striata (Min. Conch. tab. lxxx.)	Dane's Dike.
Belemnites.—1. mucronatus (Cuv. et Brong. iii. fig. 1.)	Ditto.
2. granulatus (Min. Conch. tab. dc.)	Ditto.
3. a slenderer species	Ditto.

FOSSILS OF THE RED CHALK.

Spongia ? ramose subcylindrical masses	...	...	Goodmanham.
Inoceramus Cuvieri, jun.	...	...	Speeton Cliff.
Terebratula subglobosa, jun. ...	...	...	Ditto.
Belemnites Listeri	Pl. I. fig. 18.	...	Speeton, Goodmanham, &c.
Serpula	fig. 19.	...	Speeton Cliff.

THE fossils of the Yorkshire chalk, enumerated in the preceding catalogues, are all which have fallen under my inspection (1829); and they have been obtained almost exclusively from a particular part of the stratum, and indeed chiefly from one very favourable locality. Considerable additions to their number may, therefore, be reasonably expected, when the lower beds are more accurately examined; but it appears to be the truth that the chalk-pits inland are as unproductive as a part of the sea-cliffs is rich in organic remains.

At present the deficiencies in the Yorkshire series, when compared with the chalk formation generally, are most observable in the molluscous and crustaceous tribes of animals, and in the reliquiæ of fishes and reptiles. With regard to the latter groups, geologists know that these fossils are not spread, like shells, over a vast extent of country, but often confined to limited localities. The zeal and industry of Mantell have discovered them abundantly in Sussex, but few other parts of the chalk range in England, or on the continent, can be quoted for comparison. The species of fossil shells are not in any district very numerous in the chalk, but in Yorkshire some remarkable kinds are yet undiscovered; as plagiostoma spinosum, ostrea vesicularis of Lamarck, (gryphæa globosa of Sowerby,) terebratula carnea,* and t. plicatilis, of France and England, and the cirri and trochi of Wiltshire and Sussex.

* Since discovered at Wharram.

The fossils, however, which are known to occur in the chalk of Yorkshire, are precisely those which have been always noticed by geologists as of most extensive occurrence in that stratum. The ananchytes, spatangi, inocerami, and belemnites, are precisely the shells which have been long since pointed out by Smith, Webster, Parkinson, and Mantell, as characteristic of the English chalk; and the same species have been recognised by Brongniart in the same stratum, not only over the wide surfaces which it occupies in France, but in the Netherlands, along the shores of the Baltic, and in Poland. It deserves attention that the interesting remains of spongiæ are nowhere so well developed as in England, and perhaps nowhere in England so well as in Yorkshire. On the shore near Bridlington, they lie exposed in the cliffs and scars, and, being seldom enclosed in flint, allow their organization to be studied with the greatest advantage.

FOSSILS OF THE SPEETON CLAY.

REMAINS OF PLANTS.

Wood, having the structure of dicotyledonous plants... Knapton, Speeton.

ZOOPHYTA.

Caryophyllia conulus ...	Pl. II. fig. 1. ...	Speeton.

RADIARIA.

Spatangus argillaceus	fig. 4. ...	Speeton.
Cidaris, plate and spines ...	fig. 2, 3, 5.	Ditto.
Pentacrinus caput Medusæ (Miller's Crinoidea.)		Ditto.
A round crinoidal column ...	... ...	Ditto.

MOLLUSCA.

Mya depressa (Min. Conch.) ..	fig. 8. ...	Speeton.
Mya phaseolina	fig. 13. ...	Ditto.
Pholas constricta	fig. 17. ...	Ditto.
Pholadomya decussata, (Mantell)	fig. 9. ...	Ditto.

Lutraria?	Pl. II. fig. 14.	Speeton.
Corbula punctum	fig. 6.	Ditto.
Tellina	fig. 7.	Ditto.
Isocardia angulata	fig. 20, 21.	Ditto.
Astarte lævis	fig. 18, 19.	Ditto.
Nucula ovata (Mantell)	fig. 10.	Ditto.
Nucula subrecurva	fig. 11.	Ditto.
Cucullæa	fig. 16.	Ditto.
Lucina sculpta	fig. 15.	Ditto.
Pinna gracilis	fig. 22.	Ditto.
Gryphæa sinuata (Min. Conch.) ...	fig. 23.	Ditto.
Pecten (a smooth species) ...		Ditto.
Terebratula.—1. inconstans (Min. Conch.)	fig. 24.	Speeton, Knapton.
2. tetraëdra (Min. Conch. tab. lxxxiii. fig. 4.)		Speeton. (Mr. Williamson.)
3. striatula (Mantell) ..	fig. 28.	Ditto.
4. subundata (Min. Conch.)	fig. 25.	Knapton, Speeton, also in chalk.
5. lineolata	fig. 27.	Speeton, Knapton.
Orbicula, smooth oval species ...		Speeton.
Turbo pulcherrimus (Bean MS.) ...	fig. 35.	Ditto.
Delphinula	fig. 32.	Ditto.
Turritella?	fig. 38.	Ditto.
Melania?	fig. 39.	Ditto.
Trochus reticulatus? (Min. Conch.) ...	fig. 37.	Ditto, too imperfect to identify the species, which occurs in Kimmeridge clay, Wilts.
Solarium tabulatum	fig. 36.	Speeton.
Auricula obsoleta	fig. 40.	Speeton, resembles A. incrassata, Mantell.
Rostellaria composita (Min. Conch.) ...	fig. 33, 34.	Speeton.
Ammonites.—1. Lamberti? (Min. Conch.)		Ditto.
2. venustus	fig. 48.	Ditto.
3. concinnus ...	fig. 47.	Ditto.
4. rotula (Min. Conch.)	fig. 45.	Ditto.
5. trisulcosus ...		Ditto. Differs from A. rotula, by having only three constrictions on the whorls; grows to a large size.

Ammonites.—6. marginatus	...	Pl. II. fig. 41.	
young of ditto ?	...	fig. 43.	
7. resembling a. parvus (Min. Conch.)		fig. 46.	
8. hystrix ...	...	fig. 44.	Allied to A. Mantelli, of which it may prove to be one of the many varieties.
9. fissicostatus	...	fig. 49.	
10. curvinodus	...	fig. 50.	
11. planus ? (Mantell)	...	fig. 42.	Knapton.
Indeterminate fragments, which probably belong to other species, occur at			Speeton.
Nautilus, a fragment	... ...		Ditto.
Belemnites.—1. minimus (Min. Conch. t. dlxxxix.)			Ditto.
2. lateralis, a very large species			Speeton, also in Kimmeridge clay at Brantingham.
3. jaculum ...	...	Pl. III. fig. 1.	Speeton.
Hamites.—1. maximus (Min. Conch.)		Pl. I. fig. 20, 21.	Speeton, Knapton.
2. intermedius ? (Min. Conch.)		fig. 22.	Speeton.
3. raricostatus ...	...	fig. 23.	Ditto.
4. rotundus (Min. Conch.)		fig. 24.	Ditto.
5. attenuatus (Mantell)	...	fig. 25.	Ditto.
6. alternatus (Mantell)	..	fig. 26, 27.	Ditto.
7. Beanii (Young and Bird)		fig. 28.	Ditto.
8. plicatilis ? (Mantell)	...	fig. 29.	Ditto. It grows to a large size.
9. Phillipsii (Bean MS.)	...	fig. 30.	Speeton.

ANNULOSA.

Serpula	... ...	Pl. II. fig. 30.	Speeton.
Vermicularia Sowerbii (Mantell)	...	fig. 29.	Ditto. Its whorls are either dextral or sinistral.

CRUSTACEA.

Astacus.—1. ornatus	... ...	Pl. III. fig. 2.	Speeton. Each individual lies in an oval nodule. The legs appear to have been very slender, but are not well understood.
2. claw of a large species..		fig. 3.	Speeton.

REMAINS OF FISHES AND REPTILES.

Teeth and vertebræ of fishes	... Pl. II. fig. 51, 53.	Speeton.
Teeth and vertebræ of saurian animals	fig. 52, 54.	Ditto.
Jaw-bone and teeth of Gyrodus minor (Agassiz)	fig. 55.	Ditto.

Of seventy-one species contained in the above catalogue of Speeton and Knapton fossils, one (a belemnite) appears to be also found in the lower range of blue clay, which in Yorkshire corresponds to the Kimmeridge clay; four others (mya depressa, terebratula inconstans, trochus reticulatus? ammonites Lamberti?) occur in that stratum in Wiltshire and Dorsetshire; one (gryphæa sinuata) in the lower green sand range of Kent; twelve, or perhaps thirteen, (viz. caryophyllia conulus, spatangus argillaceus, pholadomya decussata, nucula ovata, rostellaria composita, ammonites planus? belemnites minimus, hamites intermedius? h. rotundus, h. attenuatus, h. alternatus, h. plicatilis? vermicularia Sowerbii,) belong to the blue and gray marls of Bedfordshire, Kent, and Sussex; and one (terebratula subundata) is also found in the chalk. The conclusion to be drawn from this statement is, obviously, that the blue clay of Speeton in Yorkshire is especially to be referred to the gault or blue and gray marls of Cambridgeshire, Kent, and Sussex; but that it also contains some characteristic indications of the Kimmeridge clay, and therefore we should expect that in Yorkshire these two strata are not separated as in the South of England. This agrees exactly with all that can be observed of their geological position; for there is no evidence that any other stratum divides them, but on the contrary, much probability that they are in contact. Had ostrea deltoïdea been found at Speeton, there could remain no doubt on the subject; but as that fossil is known to lie near the bottom of the Kimmeridge clay, its presence at Speeton was not to be expected, because there the lower portion of the clay is not exposed. Lastly, though no layers of green sand occur in a distinct form in Yorkshire, chloritic sand accompanies most of the fossils at Knapton, and many of those at Speeton.

FOSSILS OF THE KIMMERIDGE CLAY.

Wood, agreeing in structure with dicotyledonous plants ...	Elloughton.
Ostrea deltoidea (Min. Conch. and Smith, Strat. ident.) ...	Kirby-Moorside, near Helmsley, Elloughton dale, and Welton.
Belemnites lateralis	Brantingham.
Ammonites plicomphalus ?	Kirby-Moorside.
Fragments of ammonites	From Settrington and North Grimston.

The fossils of the Kimmeridge clay in Yorkshire, owing to the rarity of its exposure, are yet very imperfectly known. Ostrea deltoïdea is believed to be characteristic of the lower part. It occurs at Elloughton, within a few feet of the red chalk; proving the great unconformity of strata beneath the Yorkshire wolds. (See Section No. 9.)

FOSSILS OF THE UPPER CALCAREOUS GRIT.

These are not numerous, nor has the stratum itself much attracted the notice of geologists. (See Philosophical Magazine for April, 1828.) The few ammonites and pectines which I have seen in it, are also found in greater abundance and perfection in the lower calcareous grit.

FOSSILS OF THE CORALLINE OOLITE.

REMAINS OF PLANTS.

Dicotyledonous wood, in a carbonaceous powdery state.			
Fruit of ? (Young and Bird, Pl. I. fig. 5.)			Neighbourhood of Malton.

ZOOPHYTA.

Spongia.—1. floriceps	... ...	Pl. III. fig. 8.	Hackness, North Grimston.
2. A smooth species	... ...		Malton, &c.
Turbinolia dispar. It varies in form, and is occasionally sub-proliferous	...	fig. 4.	Malton, &c.
Caryophyllia.—1. cylindrica. Compare with this C. annulata (Flem. Smith, fig. 3.)	...	fig. 5.	Malton, Seamer, &c.
2. like C. flexuosa (Sol. and Ellis, Pl. xxxii. fig. 1.)			Malton.
3. like C. cespitosa (Sol. and Ellis, Pl. xxxi. fig. 5.)			Hackness, Malton, &c.
Astræa.—1. favosioïdes (Smith, fig. 1.)		Pl. III. fig. 7.	Old Malton, Hackness, &c.
2. inæqualis, the cellules very unequal	...		Old Malton, &c.
3. micrastron, the cellules small, equal	...		Hackness, Ebberston, &c.
4. arachnoïdes (Flem. Park. Org. Rem. ii. vi. 4.)			Malton.
5. cells circumscribed	... ...		Old Malton.
6. tubulifera	... ...	fig. 6.	Malton.
Meandrina	... ...		Ditto.

RADIARIA.

Pentacrinus caput Medùsæ (Miller)	...		Scarborough, Langton Wold.
A round smooth crinoidal column	...	Pl. III. fig. 11.	Filey Brig, Scarborough.
A subpentagonal muricated crinoidal column Rhodocrinites echinatus of Goldfuss		fig. 9, 10.	Malton, Scarborough, also in calcareous grit.
Cidaris.—1. florigemma	...	fig. 12.	Malton, &c.
(the spine)	...	fig. 13.	
2. intermedia (Flem. Org. Rem. iii. Pl. IV. fig. 20.)			Malton, Slingsby, &c.
3. monilipora (Young and Bird, Pl. VI. fig. 3.)			Malton, Kirkdale, Langton.
Echinus germinans	... ...	Pl. III. fig. 15.	Malton, Scarborough, &c. also in calcareous grit.

Clypeus Div. 1. * with striated petaloidal ambulacra.		
1. sinuatus (Park. iii. Pl. II. fig. 1.)		Malton ? (Specimens in the collections of Mr. J. E. Lee, and the Hull Museum;) also in inferior oolite.
2. emarginatus	Pl. III. fig. 18.	Malton, Scarborough.
Div. 2. * * with biporous straight ambulacra.		
3. clunicularis (Smith, fig. 6.)...	Pl. VII. fig. 2.	Malton, Scarborough, &c. also in several other strata.
4. dimidiatus	Pl III. fig. 16.	Malton, Filey, &c. towards the bottom of the rock.
5. semisulcatus	fig. 17.	Malton, Scarborough.
Spatangus ovalis (Park.)	Pl. IV. fig. 23.	Oswaldkirk, Malton, also in calcareous grit, and Kelloways rock.
Galerites depressus	Pl. VII. fig. 4.	Malton, also in calcareous grit and cornbrash.

MOLLUSCA.

Pholas recondita	Pl. IV. fig. 19.	Malton, Scarborough.
Modiola? inclusa (in coralline bodies) ...	fig. 20.	Malton, &c.
Mya literata (Min. Conch. tab. 224.)	Pl. VII. fig. 5.	Malton, also in cornbrash, &c.
Pholadomya, resembling P. Murchisoni (Min. Conch.)		Malton.
Amphidesma? recurvum	Pl. V. fig. 25.	Malton, also in Kelloways rock.
Psammobia lævigata	Pl. IV. fig. 5.	Scarborough, &c.
Tellina ampliata	Pl. III. fig. 24.	Malton, Wass Bank, &c.
Corbis lævis ? (Min. Conch. tab. 580.)		Malton, also in calcareous grit.
Astarte.—1. ovata (Smith) ...	fig. 25.	Malton.
2. elegans (Min. Conch. tab. 137.)		Malton, Scarborough, also in inferior oolite.
3. aliena	fig. 22.	Malton, Pickering.
4. extensa	fig. 21.	Malton.
Venus, a small cordate species ...		Ditto.
Cytherea	Pl. X. fig. 12.	Ditto.
Corbula curtansata	fig. 27.	Malton, also in the Kelloways rock.

Cardium lobatum	... ...	Pl. IV. fig. 3.	Malton.
Isocardia.—1. rhomboidalis	...	Pl. III. fig. 28.	Ditto.
2. another smooth species			Ditto.
Cardita similis (Min. Conch.)	...	fig. 23.	Malton, Scarborough, also in other strata.
Trigonia.—1. costata (Min. Conch. tab. lxxxv.)			Malton, Pickering towards the top of the rock, also in other strata.
2. clavellata (Min. Conch. tab. lxxxvii.)			Malton, &c. also in other strata.
Hippopodium ponderosum (Min. Conch. tab. ccl.)			Malton, also in the lias.
Nucula, cast of the inside	...	Pl. IV. fig. 4.	Malton.
Cucullæa.—1. oblonga (Min. Conch.)	...	Pl. III. fig. 34.	Malton, also in the inferior oolite and calcareous grit.
2. contracta	... ...	fig. 30.	Ditto.
3. triangularis	... ...	fig. 31.	Ditto.
4. pectinata	... ...	fig. 32.	Malton, also in the inferior oolite and calcareous grit.
5. elongata? (Min. Conch.)		fig. 33.	Ditto, also in inferior oolite.
Arca.—1. quadrisulcata (Min. Conch. tab. ccccl xxiii.)			Malton, (rare.)
2. æmula	... ...	fig. 29.	
Modiola.—1. cuneata (Min. Con. t. ccxii.)		Pl. V. fig. 28.	Malton, also in other strata.
2. ungulata (Young and Bird, tab. vii. fig. 10.)			Malton, &c.
Trigonellites antiquatus	... ...	Pl. III. fig. 26.	Malton, (rare.)
Pinna lanceolata	... ...	Pl. IV. fig. 33.	Malton; also in calcareous grit.
Perna quadrata (Lister, tab. ccccl xxvii. and Min. Conch. tab. ccccxcii.) two varieties of it	...	Pl. IX. fig. 21, 22.	Malton, &c. also in middle oolite.
Mytilus amplus (Min. Conch.) probably perna			Malton.
Gervillia.—1. aviculoides (Min. Conch. tab. lxvi.)			Filey, Scarborough, Malton, towards the bottom of the rock; also in calcareous grit.
2. another very large species			Malton.
Avicula.—1. expansa	... ...	Pl. III. fig. 35.	Malton also in the middle oolite?
2. ovalis, the upper valve is flat		fig. 36.	Malton, Scarborough; also in calcareous grit.
3. elegantissima (Bean)	...	Pl. IV. fig. 2.	Malton.
4. tonsipluma (Young and Bird, Pl. VII. fig. 15.)			Ditto.

Plagiostoma.—1. læviusculum (Min. Conch. tab. ccclxxxii.) (three distinct varieties.)	Malton, Castle Howard, &c.
2. rigidum (Min. Conch. tab. cxiv. fig. 1.)	Malton, &c.
3. rusticum (Min. Conch. tab. ccclxxxi.)	Ditto.
4. duplicatum (Min. C. t. dlix.) Pl. VI. fig. 2.	Ditto.
Pecten.—1. abjectus ... ... Pl. IX. fig. 37.	Malton; also in the calcareous grit and middle oolite.
2. inæquicostatus ... Pl. IV. fig. 10.	Malton.
3. cancellatus (Bean, MS.) closely allied to P. cinctus (Min. Conch.)	Malton, a large species.
4. demissus ... ... Pl. VI. fig. 5.	Malton, &c. and in middle oolite, &c.
5. lens (lens et arcuatus, Min. Conch. tab. ccv.)	Malton, &c. also in several of the lower strata.
6. viminalis (Min. Conch. tab. dxliii. fig. 1, 2)	Malton, Pickering, &c.
7. vagans (Min. Conch. tab. dxliii. fig. 3, 4, 5.)	Malton; also in calcareous grit.
Lima rudis (Min. Conch. tab. ccxiv.)	Malton, and in calcareous grit.
Ostrea.—1. gregarea (Smith, fig. 4.) ...	Malton, Seamer, &c. upper part of the rock.
2. solitaria (Min. Conch. tab. ccccl xviii. fig. 1.)	Malton, &c. upper part of the rock.
3. duriuscula (Bean, MS.) Pl. IV. fig. 1.	Malton.
Chama, or gryphæa? mima ... fig. 6. (impressed by turritella)	Malton, &c. and in calcareous grit.
Gryphæa bullata? ... ... fig. 36.	More frequent in the calcareous grit.
Terebratula.—1. intermedia (Min. Conch. tab. xv. fig. 8.)	Malton, rare.
2. globata? (Min. Conch. tab. ccccxxxvi.)	Ditto.
3. bucculenta et emarginata (Min. Conch. tab. ccccxxxv., ccccxxxviii.)	Ditto.
4. ornithocephala ... Pl. VI. fig. 7.	Ditto.
5. ovata? (Min. Conch. tab. xv. fig. 3.)	Hackness.
6. obsoleta? (Min. Conch. tab. lxxxiii. fig. 7.)	Malton.
Orbicula? radiata ... ... Pl. IV. fig. 12.	Ditto.
Delphinula, spire calcarated, a large species	Ditto.
Natica.—1. arguta (Smith, fig. 2.) ...	Malton.
2. nodulata (Young and Bird, tab. xi. fig. 3.)	Malton.
3. cincta ... ... fig. 9.	Malton, (in Leeds Museum.)

Turbo.—1. muricatus (Min. Conch.) ...	Pl. IV. fig. 14.	Malton, Seamer, &c.
2. funiculatus	fig. 11.	Malton and Seamer.
Trochus.—1. granulatus (Min. Conch. tab. ccxx. fig. 2.)		Malton, Scarborough, also in calcareous grit.
2. tornatus	fig. 16.	Scarborough.
Turritella.—1. muricata (Min. Conch)	fig. 8.	Seamer, Malton, Pickering; also in the inferior oolite.
2. cingenda ? (Min. Conch. tab ccccxcix.) It belongs to the genus Nerinea.		Malton and Pickering. It is distinguishable as a variety from that in the inferior oolite.
Terebra.—1. melanioïdes	fig. 13.	Pickering.
2. ? granulata	Pl. VII. fig. 16.	Ditto.
Melania.—1. Heddingtonensis (Min. Conch. tab. xxxix.) (several varieties.)		Malton, also in cornbrash.
2. striata (Min. Conch. tab. xlvii.) ...		Brompton, Hackness, Malton, towards the top of the rock.
Bulla elongata	Pl. IV. fig. 7.	Scarborough, Seamer, Malton, in the lower beds of the rock.
Murex Haccanensis	fig. 18.	Hackness.
Ammonites.—1. perarmatus (Min. Conch. tab. ccclii.)		Malton, but more frequent in calcareous grit, and Kelloways rock.
2. triplicatus (Min. Conch. tab. ccxcii.)		Malton; also in calcareous grit.
3. plicatilis (Min. Conch. tab. clxvi.)		Malton, Oswaldkirk, &c.
4. Williamsoni ...	fig. 19.	Ayton, Mr. Williamson.
5. Lamberti ? ...		?
6. Sutherlandiæ (Min. Conch tab. dlxiii.)		Malton, but more frequent in balls in the calcareous grit, where it attains a very large size.
7. sublævis (Min. Conch.)	Pl. VI. fig. 22.	Malton.
8. excavatus (Min. Conch.)	fig. 25.	Malton; also in Kelloways rock.
9. vertebralis et cordatus (Min. Conch.)	Pl. IV. fig. 34.	Malton, &c., also common in calcareous grit.

Belemnites.—1. abbreviatus? (Miller) a large variety		Malton, Hambleton, &c. also in calcareous grit.
2. Blainvilli? (Voltz Pl. I. fig. 9.) (a very slender species much allied to B. lanceolatus (Min. Conch. tab. dc.) it also appears related to B. fusiformis (Miller, Geol. Trans. Vol. II. Pl. VIII.)		Malton.

ANNULOSA.

Vermicularia compressa (Young and Bird)	Pl. IV. fig. 17.	Scarborough.
Serpula squamosa (Bean MS.) ...	fig. 15.	Ditto.

CRUSTACEA.

Astacus rostratus	Pl. IV. fig. 20.	Malton and Scarborough; also in calcareous grit and Kelloways rock.

REMAINS OF FISHES AND REPTILES.

A FINE specimen of the palatal teeth of some fish, in five rows, was found in Slingsby quarry, and sent by the Earl of Carlisle to the Museum of the Yorkshire Philosophical Society. Two of the teeth are shewn, Plate IV. fig. 22.

Remains of ichthyosaurus occur in the oolite of Malton, especially vertebræ and teeth. A fine specimen of the lower jaw of a genuine crocodile, very like one found at Caen, and in Northamptonshire, is in the valuable collection of Malton fossils belonging to the Yorkshire Philosophical Society.

ON REVIEWING the preceding list of more than one hundred and twenty species of fossils from the coralline oolite of Yorkshire, some general results present themselves, which deserve the attention of geologists. First, it is remarkable that though many of the species are repeated in the oolitic strata below, none are found in the Speeton clay above: a result which harmonizes exactly with the observations made

on the same strata, in the south of England. If the fossils of the Kimmeridge clay could be collected in sufficient variety, possibly we might find in Yorkshire, as in the vicinity of Weymouth, some species which are also found in the oolite ; but this must only be expected at the base of the clay in stony layers, almost in contact with the rock.—(See Smith's account of the Kimmeridge (Oaktree) clay in strata identified, p. 18.)

Secondly, it is interesting to observe how large a proportion of the remains of mollusca are common to both the calcareous grit and the coralline oolite in Yorkshire and Oxfordshire. The most remarkable of these species are the following: viz. astræa favosioides, a. micrastron, a. arachnoides, a. tubulifera, meandrina, cidaris florigemma, c. intermedia, c. monilipora, clypeus clunicularis, c. dimidiatus, c. semisulcatus, corbis lævis? astarte ovata, cardita similis, gervillia aviculoides, plagiostoma læviusculum, p. rigidum, p. rusticum, pecten inæquicostatus, p. viminalis, ostrea gregarea, turbo muricatus, trochus granulatus, turritella muricata, melania Heddingtonensis, ammonites perarmatus, a. vertebralis, belemnites abbreviatus? This result is also perfectly in unison with the conclusion which suggests itself, in considering the other geological relations of these rocks : for the frequent alternation of calcareous grit and limestone beds *at the bottom of the oolite*, (see the account of Filey Brig, page 49,) and the recurrence of calcareous grit *above* the oolite, leave no doubt of the propriety of uniting these rocks into one *group or subformation*. The principal differences between the two rocks arise from the prevalence of remains of the classes zoophyta and radiaria, and the presence of melaniæ, turbines, and turritellæ in the upper beds of the coralline oolite.* Besides a considerable number of species which are so rare that we cannot pronounce whether they are peculiar to the stratum, or to the quarry that furnished them, as trigonellites antiquatus, avicula elegantissima, and a. tonsipluma, there are several common to this rock, but not yet found in the calcareous grit, as the

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* A striking proof of the accuracy of this generalization is afforded by Mr. Murchison's excellent account of the carboniferous and calcareous rocks in Sutherland ; for among the fossils which he enumerates from the calcareous grit of Braambury, *none of these* are mentioned.

corallophagous shells, pholas recondita, and modiola? inclusa; tellina ampliata; several species of crassina, cucullæa, ostrea, and terebratula; and generally the shells of cephalous mollusca.

Thirdly, a great number of the shells in this stratum occur again, with only slight variations, in several of the conchiferous strata below; as, turritella muricata and t. cingenda in the inferior oolite; perna quadrata in the middle oolite; mya literata, clypeus clunicularis, and galerites depressus in the cornbrash; corbula curtansata, pecten demissus, spatangus ovalis, ammonites perarmatus, and astacus rostratus in the Kelloways rock.

Here again we find that agreement between the conclusion obtained by considering rocks in relation to their position and quality on the one hand, and their organic contents on the other, which is the most satisfactory proof of the accuracy of each mode of investigation. For either of these methods of inquiry will convince us of the propriety of grouping together all the strata from the coralline oolite downwards to the inferior oolite, in one great family of rocks naturally divided into two formations, as expressed in the general table of Yorkshire strata, pages 2 and 3.

FOSSILS OF THE LOWER CALCAREOUS GRIT.

REMAINS OF PLANTS.

Wood of a dicotyledonous plant		Leavening, Scarborough, &c.

ZOOPHYTA AND RADIARIA.

Spongia (a confused mass) ...		Scarborough	Also in the coralline oolite.
Round smooth crinoidal column ...		Ditto.	
Muricated ditto	Pl. III. fig. 9.	Ditto.	
Echinus germinans	fig. 15.	Ditto.	

Cidaris vagans	Pl. VII. fig. 1.	Scarborough and in other strata.
Spatangus ovalis, Leske	Pl. IV. fig. 23.	Scarborough; also in the coralline oolite and Kelloways rock.
Clypeaster pentagonalis	fig. 24.	Scarborough.
Galerites depressus	Pl. VII. fig. 4.	Scarborough; also in other lower strata.

MOLLUSCA.

Pholadomya.—1. simplex	Pl. IV. fig. 31.	Gristhorpe (rare.)
2. deltoïdea? (Min. Conch. tab. cxcvii.)		Malton, and in other lower strata.
Sanguinolaria undulata (Min. Conch.)	Pl. V. fig. 1.	Malton, and in lower strata.
Mya literata (Min. Conch.) ...	Pl. VII. fig. 5.	Malton, Scarborough, and in other strata.
Isocardia tumida	Pl. IV. fig. 25.	Gristhorpe and Cayton.
Astarte carinata?	Pl. V. fig. 3.?	Scarborough, and in Oxford clay.
Venus	Pl. IV. fig. 26.	
Lucina crassa (Min. Conch. tab. dlvii.)		Deepdale head, and Scarborough; also in other lower strata.
Modiola bipartita (Min. Conch.) ...	fig. 30.	Gristhorpe, Malton, Sutherland.
Avicula ovalis	Pl. III. fig. 36.	Scarborough (rare in this rock.)
Lima rudis (Min. Conch. tab. ccxiv.) ...	...	Malton and Sutherland.
Gryphæa.—1. bullata? (Min. Conch.)	Pl. IV. fig. 36.	Malton, Filey, and Birdsall.
2. chamæformis (beaks laterally involute)		Abundant at Hackness, and Gristhorpe.
3. inhærens, a species? which differs from bullata, by the large attachment of its beak		Birdsall.
Ostrea gregarea (Min. Conch. tab. cxi.)		Scarborough (rare in this rock.)
Terebratula.—1. socialis ...	Pl. VI. fig. 8.	Scarborough, Hackness, &c. in groups.
2. intermedia (Min. Conch.)		Castle Howard.
3. ornithocephala (Min. Conch.)		Ditto.

Cirrus cingulatus	Pl. IV. fig. 28.	Scarborough, (rare, in Mr. Bean's cabinet.)
Actæon retusus	fig. 27.	Scarborough, (rare, in Mr. Williamson's cabinet.)
Turritella muricata (Min. Conch.)	fig. 8.	Ditto, rare in this rock.
Rostellaria bispinosa?	Pl. VI. fig. 13.?	Scarborough.
Trochus.—1. granulatus (Min. Conch. tab. ccxx.)		Gristhorpe.
2. bicarinatus (Min. Conch. tab. ccxxi. fig. 2.)		
Belemnites abbreviatus (Miller, G. Trans. vol. II. Pl. 7. fig. 9.)		Malton and Hambleton.
Ammonites.—1. Sutherlandiæ? (Min. Conch. tab. dlxiii.) (a gigantic species)		In calcareo-siliceous nodules at Gristhorpe.
2. perarmatus (Min. Conch. tab. ccclii.)		Scarborough, Filey Brig, also in the Kelloways rock.
3. instabilis. Discoid, whorls all apparent radiated; radii acute, bold, on the inner whorls bifurcated, on the outer ones entire and subtuberculated. Aperture ovato-orbicular entire. Six inches diameter		Gristhorpe, Pickering, &c.
4. solaris ...	Pl. IV. fig. 29.	Scarborough, (Williamson.)
5. vertebralis (Min. Conch.)	fig. 34.	Acklam, Birdsall, Pickering, Troutsdale, Hackness, Scarborough, &c.

ANNULOSA.

Dentalium	Pl. IV. fig. 37.	Cayton.
Serpula lacerata	fig. 35.	Scarborough.
Scales of fishes		Near Howsham.

A CONSIDERABLE proportion of these fossils belongs to the upper solid beds which are in contact, and sometimes alternate, with the base of the coralline oolite. It has been remarked above, that the zoological characters of those two rocks are much in unison, and there are very few species of frequent occurrence in the calcareous grit, which are not also discovered in the limestone above. A few fossils, which are not among the most common in the calcareous grit, as galerites depressus,

mya literata, and turritella muricata, are repeated in the cornbrash and oolites below it; others, as spatangus ovalis, terebratula socialis, and ammonites perarmatus, are found as low as the Kelloways rock; and sanguinolaria undulata and astarte carinata? have been met with in the Oxford clay; but a considerable number remain, which are so constantly associated with this rock, that they may be employed to identify it in a case otherwise doubtful. Such are isocardia tumida, modiola bipartita, pinna lanceolata, pecten vagans, lima rudis, gryphæa bullata, and ammonites vertebralis; not to mention several rarer species, of which the value in characterizing the rock remains to be ascertained.

Mr. Murchison's paper, to which I have already referred, on the geology of Brora, affords an opportunity of applying these results to determine the geological relation of the rubbly limestone and sandstone of Braambury hill, the uppermost stratum of that district. In its position with respect to other conchiferous beds there, it agrees with the calcareous grit of Yorkshire, and amongst the fossils which Mr. Murchison has there collected, we find gryphæa bullata,? modiola bipartita, pecten vagans, and ammonites vertebralis. Of these I have had the opportunity of consulting specimens, which the liberality of their discoverer has placed in the museum of the Yorkshire Philosophical Society, and others presented to me by my friend Mr. Marshall. The same museum contains a suite of fossils from the calcareous grit of Oxfordshire, presented by Dr. Buckland, amongst which we recognize ammonites vertebralis and pinna lanceolata. Ammonites vertebralis was obtained by Mr. Smith from this rock at Derry-hill, Wilts, and pinna lanceolata by Professor Sedgewick at Weymouth. In these instances the zoological characters of a rock are shewn to be constant from one end of the island to the other, though its thickness and mineralogical appearance are subject to great variations, and in one example the deposit is insulated and distant four hundred miles from its kindred strata. The coralline oolite, (and calcareous grit?) with pecten viminalis, ammonites plicatilis, &c. contribute to form the upper part of the Jura limestone of Switzerland, and have been observed at several places on the north coast of France.

FOSSILS OF THE OXFORD CLAY.

MOLLUSCA.

Mya.—1. literata	Pl. VII. fig. 5.	Scarborough, Ebberston, and in other strata.
2. resembling mya depressa (Min. Conch. t. ccccxviii.)		Scarborough.
Sanguinolaria undulata (Min. Conch.)	Pl. V. fig. 1.	Ditto, also in other strata.
Astarte.—1. lurida (Min. Conch. tab. cxxxvii.)	fig. 2.	Scarborough.
2. carinata	fig. 3.	Ditto, also in calcareous grit, and Kelloways rock.
Pholadomya obsoleta	fig. 24.	Scarborough, also in the Kelloways rock.
Modiola cuneata (Min. Conch. tab. ccxi.) (a large variety)	fig. 28.	Scarborough, also in other strata.
Nucula.—1. elliptica	fig. 6.	Scarborough.
2. (an inside cast) ...	fig. 4.	Ditto.
3. nuda (Young and Bird) ...	fig. 5.	Ditto (an inside cast.)
Cucullæa concinna	fig. 9.	Scarborough.
Pinna mitis	fig. 7.	Ditto.
Trigonellites politus	fig. 8.	Ditto.
Plagiostoma.—1. with very fine striæ	fig. 10.	Ditto.
2. duplicatum ...	Pl. VI. fig. 2.	Ditto, also in other strata.
Avicula expansa	Pl. III. fig. 35.	Scarborough.
Pecten.—1. with concentric furrows ...	Pl. V. fig. 11.	Ditto.
2. another species ...		Ditto.
Perna		Ditto.
Ostrea.—1. an upper valve ...	fig. 12.	Ditto.
2. inæqualis	fig. 13.	Ditto.
Unknown	fig. 18.	Ditto.
Rostellaria trifida (Bean, MS.) ...	fig. 14.	Ditto.
Patella latissima (Min. Conch. tab. cxxxix.)		Ditto, and Ebberston.
Belemnites.—1. abbreviatus (Miller, G. Trans.)		Scarborough.
2. gracilis. It differs from B. fusiformis by wanting the deep longitudinal groove.	fig. 15.	Ditto.
Ammonites.—1. vertebralis? (Min. Conch.)	Pl. IV. fig. 34.?	Ditto.
2. oculatus	Pl. V. fig. 16.	Ditto.
3. probably a young specimen	fig. 17.	Ditto.

Ammonites.—4. Vernoni (Bean)	...	Pl. V. fig. 19.	Ditto, and Ebberston.
5. athleta ...	...	Pl. VI. fig. 19.	Scarborough.
6. a large imperfect species			Ditto.

ANNULOSA, CRUSTACEA, AND FISHES.

Serpula.—1. intestinalis ...	...	Pl. V. fig. 21.	Scarborough, and in the cornbrash.
2. a tapering unattached hook-formed species, with four longitudinal furrows, having some analogy to Smith's figs. 5, 6.			Scarborough, (my collection.)
Astacus (a didactyle claw)	...	fig. 20.	Scarborough.
Tooth of squalus ...	...	fig. 22.	Ditto.

THE gray shale of Scarborough castle-hill, which represents the Oxford clay of the south of England, belongs to the same great formation as the calcareous grit and the Kelloways rock, and, being situated between them, contains several fossils which are also found in one or other of those rocks. It appears to me that mya literata, sanguinolaria undulata, and crassina carinata, are found in all these strata, and perhaps in some others. I am not positive that the shell named ammonites vertebralis is really identical with that in the calcareous grit; but there can be no doubt that a. athleta is repeated in the Kelloways rock. A considerable number of fossils remain, which have not yet been discovered in any other stratum: but as these have, for the most part, been found in only one locality at the bottom of the stratum, we must wait, I think, for further discoveries, before pronouncing how far they are to be considered characteristic. Judging from very limited experience, I am disposed to think ammonites Vernoni, belemnites gracilis, and patella latissima, most likely to be useful in this respect. This clay is so intimately connected with the subjacent Kelloways rock in Yorkshire, as well as in the south of England, that we might almost adopt the language of Mr. Smith, who says, (Strata identified, page 22,) "In several instances where the bottom of the clay contains the same fossils as the rock which it covers, it is difficult to say to which stratum they belong." At Dunrobin in Sutherland, Mr. Murchison collected fossils which, from their agreement with those contained in the above catalogue, seem fully to

justify his opinion that the stratum there occurring, (see Geol. Trans. Vol. II. pages 302, 319, 361, &c.) is a detached part of the Oxford clay and Kelloways rock. Amongst them, his descriptions leads me to recognise ammonites Vernoni, modiola pulchra, (Pl. V. fig. 26,) belemnites gracilis, astarte lurida, &c. &c.

FOSSILS OF THE KELLOWAYS ROCK.

Wood of a dicotyledonous plant		Scarborough, Newton Dale.
Spatangus ovalis	Pl. IV. fig. 23.	Hackness, (in Mr. C. Preston's collection,) also in calcareous grit.
Mya.—1. a cast of the inside ...	Pl. V. fig. 23.	Scarborough.
2. literata (Min. Conch.) ...	Pl. VII. fig. 5.	Scarborough, and in other strata.
3. calceiformis (a large transverse shell) ...		Ditto, Scalby, and South Cave, and in other strata.
Pholadomya obsoleta	Pl. V. fig. 24.	South Cave, Hackness, also in the Oxford clay.
Corbis ?.—1. ovalis	fig. 29.	South Cave, Scarborough.
2. lævis ? (Min. Conch.) ...	fig. 32.	South Cave, and in coralline oolite.
Corbula curtansata	Pl. III. fig. 27.	South Cave, and in coralline oolite.
Amphidesma recurvum	Pl. V. fig. 25.	Scarborough, and in coralline oolite.
Lucina lirata	Pl. VI. fig. 11.	Scarborough.
Astarte.—1. carinata	Pl. V. fig. 3.	South Cave, and in Oxford clay.
2.	fig. 30.	South Cave, and Newbald.
Cardium dissimile? (Murchison) ...	fig. 27.	Scarborough, and South Cave (a cast.)
Trigonia clavellata (Min. Conch. tab. lxxxvii.)		South Cave, Newton Dale, and in other strata.
costata (Min. Conch. tab. lxxxv.)		Hackness.

Modiola.—1. pulchra	Pl. V. fig. 26.	Scarborough.
2. cuneata ? (Min. Conch. tab. ccxi.) (it is a large shell)	fig. 28.	South Cave, Scarborough, and in other strata.
Cucullæa concinna ? (of Oxford clay)	fig. 31.	South Cave (a cast.)
Pinna mitis ?	fig. 7. ?	South Cave.
Avicula.—1. Braamburiensis (Min. Conch.)	Pl. VI. fig. 6.	Scarborough, Hackness, &c.
2. expansa	Pl. III. fig. 35.	South Cave, and in coralline oolite.
Gervillia		Newton Dale.
Lima rudis (Min. Conch. tab. ccxiv.) ...		Scarborough, and in calcareous grit.
Plagiostoma duplicatum (Min. Conch.) (large cast of the inside)	Pl. VI. fig. 2.	Scarborough, Hackness.
Pecten.—1. fibrosus (Min. Conch.) ...	fig. 3.	Scarborough, Hackness (a large variety.)
2. lens (Min. Conch. tab. ccv.)		South Cave, &c. and in other strata.
3. demissus	fig. 5.	Scarborough, and in cornbrash.
Ostrea.—1. undosa (Bean MS.) ...	fig. 4.	Scarborough.
2. archetypa (o. deltoïdea Murchison)	fig. 9.	Scarborough, and Wheatcrofts.
3. Marshii (Min. Conch. tab. xlviii.)		Wheatcrofts cliffs, and in cornbrash.
Gryphæa dilatata (Min. Conch.) ...	fig. 1.	Scarborough, Hackness.
Perna quadrata (Min. Conch. tab. 492.)	Pl. IX. fig. 21.	South Cave, (cast,) and in other strata.
Terebratula.—1. ornithocephala (Min. Conch.)	Pl. VI. fig. 7.	Scarborough, Hackness, and in other strata.
2. socialis	fig. 8.	Scarborough, Hackness, and in calcareous grit.
Turbo sulcostomus (three or four sharp spiral costæ, the right lip grooved within.)	fig. 10.	Hackness, South Cave, (casts.)
Cirrus depressus	fig. 12.	Hackness, Scarborough.
Trochus guttatus	fig. 14.	Scarborough.
Turritella muricata (Min. Conch.) ...	Pl. IV. fig. 8.	South Cave, and in other strata.
Rostellaria bispinosa	Pl. VI. fig. 13.	Scarborough.

Belemnites.—1.	abbreviatus (Miller, Geol. Trans.)		Scarborough, Hackness.
2.	tornatilis, an elongated species,		Scarborough.
Nautilus hexagonus?	(Min. Conch. tab. dxxix.)		Mr. Bean's collection.
Ammonites.—1.	plicatilis (Min. Conch. tab. clxvi.)		In Mr. Williamson's collection.
2.	Kœnigi (Min. Conch.)	fig. 24.	Hackness, South Cave.
3.	bifrons	fig. 18.	Hackness, (in the author's collection.)
4.	Gowerianus (Min. Conch. t. dxlix.)		Hackness, Scarborough.
	a variety of the same	fig. 21.	Ditto, Newton Dale.
5.	perarmatus (Min. Conch. tab. ccclii.)		Scarborough, also in calcareous grit.
6.	athleta	fig. 19.	Hackness, (in the author's collection.)
7.	Calloviensis (Min. Conch.)	fig. 15.	Hackness, Scarborough, and South Cave.
8.	Duncani (Min. Conch.)	fig. 16.	Hackness.
9.	gemmatus ...	fig. 17.	Scarborough.
10.	sublævis (Min. Conch.) ...	fig. 22.	Hackness, no perfect specimens have been found.
11.	a species resembling Herveyi? (Min. Conch. tab. cxcv.)		Scarborough.
12.	flexicostatus ...	fig. 20.	Hackness.
13.	funiferus. It nearly resembles a. excavatus	fig. 23.	Scarborough, (author's collection.)
14.	excavatus (Min. Conch. tab. cv.)	fig. 25.	Scarborough.
15.	a very peculiar subcarinated species, with a short spiral sulcus near the aperture, and sigmoidal bifid ribs prominent on the inner part of the volution		Scarborough, (Mr. Williamson's collection.)
16.	an imperfect sub-carinated species		Scarborough.

CRUSTACEA, REPTILES, &c.

Astacus rostratus	Pl. IV. fig. 20.	Hackness.
Coracoid bone? of a saurian animal ...		Scarborough.

The Kelloways rock, seldom exposed in a satisfactory manner in the south of England, and either deficient or concealed beneath the Oxford clay from Wiltshire northward to the Humber, would perhaps never have been recognised in Yorkshire without attention to its highly characteristic fossils. In the winters of 1820 and 1821, Mr. Smith collected some specimens of ammonites calloviensis, and a. Kœnigi, from the north cliff of Scarborough; which, the moment I saw them, convinced me that he had discovered the Kelloways rock in Yorkshire. Subsequent investigation, by proving that the rock which had furnished these "silent witnesses," occupied, relatively to other strata above and below it, exactly the place of the Kelloways stone, removed all doubt from Mr. Smith's mind, and enabled him to demonstrate that, amidst the acknowledged anomalies of the lower oolitic series on this coast, the lines of geological agreement may be securely drawn, to unite them with their types in the midland and southern counties. His inferences on the subject, like many other of his valuable observations, have now become the common property of geologists, without the intervention of any publication by himself, which might remind those who profit by his labours of the praise that is due to the disinterested liberality of his communications.

Of sixty species enumerated above, one-half the number occur likewise in other strata on the coast of Yorkshire; twenty-six of these have been seen in the superior strata of the coralline oolite formation; twelve exist in inferior rocks which belong the Bath oolitic series, and at least eight are diffused alike through the strata above and below it. These are dicotyledonous wood, mya literata, mya calceiformis, trigonia clavellata, modiola cuneata, pecten lens, perna quadrata, turritella muricata. Of the thirty species which remain, future researches may prove a considerable portion to be characteristic of this remarkable rock, but at present I shall content myself with pointing out those which my own experience in Yorkshire has taught me to confide in, and which, therefore, it may be hoped, will not mislead others. These are the ammonites generally, but ammonites calloviensis, and a. Kœnigi, especially, (for that which Mr. Sowerby figures from the lias in connexion with the Kel-

loways fossil, appears to me quite distinct,) and the small variety of gryphæa dilatata. These are the very fossils which Mr. Smith so long ago pointed out as proper to identify this rock in Wiltshire, and it is worth remarking, that every species figured on his plate as characteristic of the stratum in the southern counties, may, with suitable precaution, be employed for the like purpose in Yorkshire. This rock seems unknown beyond the British islands, and its fossils are not, I believe, described by any foreign geologist (1829.) (Several however may be recognised in the fine collection in the Strasburgh museum, 1830.)

FOSSILS OF THE CORNBRASH.

ZOOPHYTA AND RADIARIA.

Cellaria Smithii	Pl. VII. fig. 8.	Scarborough, attached to cardium citrinoïdeum.
It seems to belong to the genus hippothoa, Lamx. see his Expos. Meth. t. lxxx. fig. 16.		
Millepora straminea	Pl. IX. fig. 1.	Scarborough (very rare in this stratum.)
Cidaris vagans	Pl. VII. fig. 1.	Scarborough, and in other strata.
Clypeus.—1. clunicularis Llwyd ...	fig. 2.	Ditto.
2. orbicularis ...	fig. 3.	Scarborough.
Galerites depressus ...	fig. 4.	Ditto, and in other strata.
Pentacrinus caput medusæ (Miller's Crinoïdea)		Ditto.

MOLLUSCA.

Mya literata (Min. Conch.) ...	Pl. VII. fig. 5.	Scarborough, and in other strata.
Sanguinolaria undulata (Min. Conch.)	Pl. V. fig. 1.	Ditto.
Pholadomya.—1. Murchisoni (Min. Conch.)	Pl. VII. fig. 9.	Scarborough.
2. ovalis (Min. Conch. tab. ccxxvi.)		Ditto.
Amphidesma.—1. decurtatum ...	fig. 11.	Scarborough and Gristhorpe.
2. securiforme ...	fig. 10.	Scarborough, Newton Dale.
Unio peregrinus (Pullastra, Murchison)	fig. 12.	Ditto.
Isocardia minima (Min. Conch. tab. ccxcv.)	fig. 6.	Ditto.
Cardium citrinoïdeum ...	fig. 7.	Ditto.

Trigonia clavellata (Min. Conch. tab. lxxxvii.)		Scarborough, Gristhorpe, and in other strata.
Modiola cuneata (Min. Conch. tab. ccxi.) (a large variety)	Pl. V. fig. 28.	Scarborough.
Pinna cuneata (Bean, MS.) ...	Pl. IX. fig. 17.	Scarborough, and in the Cave oolite.
Plagiostoma.—1. rigidulum ...	Pl. VII. fig. 13.	Scarborough. It seems to be distinct from P. rigidum, and is invariably smaller.
2. interstinctum. (It has fewer ribs than plagiostoma duplicatum (Min. Conch.)	fig. 14.	Scarborough. This is the usual size of the species in cornbrash.
Pecten.—1. fibrosus (Min. Conch.)	Pl. VI. fig. 3.	Scarborough, Newton Dale.
2. demissus ...	fig. 5.	Scarborough, Gristhorpe, and in other rocks.
3. a species like viminalis, but with more numerous ribs ...		Scarborough.
Ostrea.—1. Marshii (Min. Conch. tab. xlviii.)	...	Scarborough, Gristhorpe, Newton Dale, &c.
2. a small oval species	...	Scarborough.
Terebratula.—1. ovoides? (Min. Conch. tab. c. also Young and Bird, tab. viii. fig. 10.)		Scarborough, Gristhorpe, Newton Dale.
2. digona (Min. Conch. tab. xcvi.)	...	Scarborough, (rare.)
Trochus granulatus (Min. Conch. tab. ccxx.) ...	...	Scarbro', and in other strata.
Terebra? granulata	Pl. VII. fig. 16.	Ditto. (Mr. Williamson.)
Melania.—1. Heddingtonensis (Min. Conch. tab. xxxix.)		Scarborough, Gristhorpe, and in other strata.
2. vittata	fig. 15.	Scarbro', Gristhorpe. (One specimen inclosed a mass of crystallized blende.)
Bulla? or Actæon? (which I have not seen; it is in the collection of Mr. Preston)		Scarborough.
Ammonites.—1. Herveyi (Min. Conch. tab. cxcv.)		Ditto.
2. terebratus, similar but more globular species, with a very acute, narrow umbilicus		Ditto.
(Belemnites are rare in the cornbrash of Yorkshire.)		
Vermicularia nodus	Pl. IX. fig. 34.	Ditto, and in the Cave oolite.

Serpula intestinalis	...	...	Pl. V. fig. 21.	Scarborough, common.
quadrata...	...	...	...	...	Newton Dale.

It is not so much by the presence of particular species of fossils which are found in no other stratum, that the cornbrash can be accurately identified from Somersetshire to Lincolnshire, as by the *occurrence together* in it of some fossils which are repeated in rocks above, and several others which are found in those beneath. For, in the preceding list of thirty-seven species obtained from this stratum in Yorkshire, nearly two-thirds are certainly known to be repeated in other rocks, and possibly this proportion may be increased by more scrupulous researches. But this circumstance, whilst it confirms the inferences, derived from other considerations, of the general analogy among all the members of the oolitic formations on this coast, does not prevent the employment of zoological characters, to discriminate the cornbrash from its associated rocks, though it certainly demands a caution in their application, which is not always observed.

Several fossils not peculiar to the cornbrash, as millepora straminea, pinna cuneata, amphidesma securiforme, and a. decurtatum, unio peregrinus, vermicularia nodus, and ostrea Marshii, seem to be repeated only in the lower oolitic formation, and the large variety ? of modiola cuneata, melania vittata, and perhaps pecten demissus, have yet been found only in the upper oolite formation; whilst the remains of echinida and pentacrinus, mya literata, sanguinolaria undulata, trigonia clavellata, pecten fibrosus, trochus granulatus, terebra granulata, and melania Heddingtonensis, are common to both these formations, either in Yorkshire or in other parts of England. The cornbrash is the only conchiferous stratum in the eastern part of Yorkshire in which belemnites are particularly rare, and it seems at present to be the only repository of clypeus orbicularis, isocardia minima, cardium citrinoïdeum, plagiostoma rigidulum, terebratula ovoides, and t. digona, ammonites Herveyi, and a. terebratus. But though these shells should eventually be discovered in other strata, the cornbrash may still be discriminated in any local district, and satisfactorily identified in distant countries. By its clypei,

galerites, and cidarites, geologists will at once refer it to the strata which intervene between the Kimmeridge clay and the lias; the abundance of amphidesma securiforme, isocardia minima, pinna cuneata, and ostrea Marshii, and the absence of gryphæa dilatata, ammonites perarmatus, and spatangus ovalis, will connect it with the Bath oolite formation generally, whilst a faithful comparison of its whole suite of organic remains, with those of the Stonesfield slate and forest marble, and upper and lower oolites of Bath respectively, will always be sufficient to discriminate these rocks, even where no aid can be derived from observations of its geological position. The specimens which I have had the opportunity of consulting are insufficient to demonstrate the existence of cornbrash in a distinct character above the coal of Brora.

FOSSILS OF THE UPPER SANDSTONE AND SHALE.

These consist entirely of the remains of plants, of the natural families, equisetaceæ, lycopodineæ, filices, cycadeæ, and palmæ, (Sternberg,) and of fibrous and ramified wood. Only one locality, a bed of shale with nodular ironstone, at the island between Red cliff and Gristhorpe cliff, has produced the more delicate species; but this is rather owing to their more fortunate exposure in that situation, by the extension of the shale along the shore, than to their absolute deficiency at other places in the same range. Traces of equisetiform and cycadiform plants may, with attention, be perceived at the White Nab; a beautiful sphænopteris has been found by Mr. Bean at Scalby; and dicotyledonous wood, in fragments and branches, occurs generally in the sandstone rocks above the gray limestone, or Bath oolite. The following catalogue includes the species which appear to me to be certainly distinct, grouped chiefly after Brongniart's method, according to the arrangement and neuration of their leaves. I have ventured to assign names to the new species, subject to the correction of more experienced botanists, for whom I have endeavoured faithfully to copy the characteristic structure of the plants. (See the Synoptic Table of Organic Remains in a future page.)

MONOCOTYLEDONOUS PLANTS.

Equisetum (traces of)		At the White Nab.
Lycopodites uncifolius	Pl. VIII. fig. 3.	Also in the lower sandstone.
magnified leaf of ditto ...	3. a.	
Thuites expansus? Sternberg ...	Pl. X. fig. 11.	Also in lower sandstone.
Scolopendrium solitarium ... ... (Sternberg, tab. xxxvii. fig. 2.)	Pl. VIII. fig. 5.	Also in the lower sandstone and shale; also Brandsby in slaty limestone.
Aspleniopteris Nilsoni? ... ... (Sternberg, tab. xviii. figs. 3, 4, 5?)	fig. 4.	The nervures stronger than in Sternberg's specimen from Hör.
Sphænopteris.—1. digitata ...	fig. 6.	Compare Sph. laxa, Sternberg.
2. stipata ...	fig. 4.	Also in the lower sandstone.
3. latifolia ...	Pl. VII. fig. 18.	From Scalby. (Mr. Bean.)
4. longifolia ...	fig. 17.	Rare.
Neuropteris lobifolia	Pl. X. fig. 13.	Uncommon (Mr. C. Preston.)
Pecopteris.—1. ligata	Pl. VIII. fig. 14.	Also in the lower sandstone.
2. paucifolia	fig. 8.	Leaves never seen attached.
3. hastata	fig. 17.	Leaves very crowded.
4. recentior	fig. 15.	Resembles osmunda gigantea (neuropteris flexuosa) of the west-riding collieries.
5. curtata, the leafits longer than usual, and granulated	fig. 12.	Upper surface. Is this appearance accidental? the seed vessels appear to run along the secondary nervures.
6. exilis	fig. 16.	Upper surface, marked with round swellings over the seed vessels.
7. cæspitosa	fig. 10.	Rare.
8. crenifolia	fig. 11.	Enlarged capsules at 11 a.
Cycadites.—1. comptus	Pl. VII. fig. 20.	
2. tenuicaulis	fig. 19.	
3. sulcicaulis	fig. 21.	Dr. Murray's specimen.
4. pecten	fig. 22.	

Supposed small strobilus	Pl. VIII. fig. 1.	
Supposed winged seed	fig. 2.	
Flabellaria ? viminea	Pl. X. fig. 12.	Also in the lower sandstone.
Unknown leaves.—1. ...	Pl. VIII. fig. 24.	
2.	fig. 23.	Never united to a stem.
3.	fig. 25.	Often in groups.

DICOTYLEDONOUS PLANTS.

Phyllites nervulosus, Sternberg ...	Pl. VIII. fig. 9.
Wood carbonized, in branches and fragments.	

The rich repository of these plants under Gristhorpe cliff, was discovered in the autumn of 1827; and Messrs. Bean and Williamson have presented duplicates to many of the public museums in the north of England. Some have been since transmitted by the Yorkshire Philosophical Society to M. A. Brongniart, in whose great work on fossil vegetables their natural affinities will no doubt be effectually displayed. Almost all the species are new; but two of them have been described from Hör, in Scania, and two others from Stonesfield in Oxfordshire. Some remarks on their geological relations will be found appended to the account of the analogous, and partly identical, reliquiæ of the lower carbonaceous sandstone and shale.

Since the first publication of this work in 1829 my indefatigable friends above-named have continued their researches, and brought to light some new species, which are described and figured in the 'Histoire des Vegetaux Fossiles,' and the 'Fossil Flora of Great Britain.'

Mr. Bean has supplied me with excellent specimens of the Gristhorpe and Haiburn plants known in 1829; many of the new published species have come under my examination; and the complete list, with synonyms and references, is contained in the General Synoptic Table of Organic Remains which is added to this edition.

FOSSILS OF THE GRAY LIMESTONE OR OOLITE, OF CLOUGHTON, BRANDSBY, AND CAVE.

REMAINS OF PLANTS.

Fragments of carbonized wood occur in this limestone near Scarborough, and in Sutherland; and I once found a species of cycadites mixed with its shells in Stainton dale cliff. Cycadites lanceolatus, and scolopendrium solitarium, occur in the slaty limestone of Brandsby.

ZOOPHYTA AND RADIARIA.

Millepora straminea	Pl. IX. fig. 1.	Gristhorpe, Cloughton, Owlston, Crambe, Westow, Ellerker.
Retepora?	fig. 2.	Westow.
Tubipora, or eunomia (Lamx. Pl. lxxxi. fig. 10.)		Terrington.
Pentacrinus caput Medusæ (Miller) ...		Brandsby, Gristhorpe, Hood hill, &c.
Cidaris.—1. vagans	Pl. VII. fig. 1.	Near Scarborough.
2. single plates ...		Ewe Nab and Gristhorpe.
Spines of cidaris.—1. smooth ...	Pl. IX. fig. 3.	Ewe Nab, Hood hill, &c.
2. muricated ...	fig. 4.	Gristhorpe, Ewe Nab, &c.
3. tuberculated ...	fig. 5.	Gristhorpe and Cloughton.
Echinus germinans	Pl. III. fig. 15.	Whitwell.

MOLLUSCA.

Mya calceiformis	Pl. XI. fig. 3.	Brandsby, Cloughton, and in other strata.
Lutraria gibbosa? (Min. Conch.)	Pl. IX. fig. 6.	Brandsby, near Scarborough, and Bath.
Psammobia lævigata	Pl. IV. fig. 5.	Brandsby, Cloughton, and in coralline oolite.
Amphidesma decurtatum	Pl. VII. fig. 11.	White Nab, &c.
Pholadomya.—1. acuticostata (Min. Conch. tab. dxlvi.)		Brandsby, in slaty stone.
2. nana	Pl. IX. fig. 7.	White Nab.
3. producta? (Min. Conch. tab. cxcvii.)		Newborough Park, (near Coxwold.)
4. obliquata ...	Pl. XIII. fig. 15.	Sancton, Cloughton, &c. (common in the marlstone.)

Corbula depressa	Pl. IX. fig. 16.	Cloughton Wyke.
Isocardia.—1. nitida ? (or variety of minima ?) ...	fig. 10.	Ditto.
2. concentrica (Min. Conch. tab. ccccxci.)		Crambe Bridge, and near Cave.
3. angulata ? ...	fig. 9.	Near Scarborough and Speeton ?
Cardium.—1. cognatum (allied to citrinoïdeum) ...	fig. 14.	Cloughton Wyke.
2. acutangulum ...	Pl. XI. fig. 6.	Brandsby and inferior oolite sand.
3. semiglabrum ...	Pl. IX. fig. 15.	Cloughton Wyke.
Cardita similis (Min. Conch. tab. ccxxxii.)		Ditto.
Cytherea dolabra	fig. 12.	Ditto.
Pullastra recondita	fig. 13.	Ditto.
Astarte minima	fig. 23.	Brandsby, Cloughton Wyke, and Commondale.
Lucina despecta	fig. 8.	Cloughton and inferior oolite sand.
Trigonia.—1. costata (Min. Conch. tab. lxxxv.)		White Nab, &c.
2. conjungens ? (a species between t. angulata and t. clavellata, Min. Conch.)		Brandsby.
Modiola.—1. imbricata (Min. Conch. tab. ccxii.)		Smaller than Pl. V. fig. 28.
2. ungulata (Young & Bird, Pl. VII. fig. 10.)		Cloughton and in coralline oolite.
Pinna cuneata	fig. 17.	Cloughton and other strata.
Cucullæa.—1. imperialis (Bean, MS.)	fig. 19.	Cloughton Wyke (cast.)
2. cylindrica ...	fig. 20.	White Nab, (author's collection.)
3. cancellata ...	fig. 24.	Cloughton and inferior oolite sand.
4. elongata (Min. Conch. tab. ccccxlvii.)		Near Cave.
Indications of another species at ...	...	Sancton.
Nucula.—1. variabilis (Min. Conch.)	fig. 11.	Cloughton Wyke and inferior oolite sand.
2. lachryma (Min. Conch.) (blunt variety)	fig. 25.	Ditto.
Perna quadrata (Min. Conch.) ...	fig. 21, 22.	Cloughton Wyke, White Nab, Commondale.

Gervillia acuta (Min. Conch. tab. dx.) ... (shell thin, hinge pits obscure)	Pl. IX. fig. 36.	Brandsby, White Nab, and Cloughton.
Avicula Braamburiensis (Min. Conch.)	Pl. VI. fig. 6.	White Nab, Cloughton, Commondale, and in other strata.
Plagiostoma.—1. like P. cardiiforme (Min. Conch. t. cxiii.)		Ellerker, near Cave.
2. a smooth species ...		Westow, near Malton.
3. interstinctum ...	Pl. VII. fig. 14.	Whitwell, Owlston, Cloughton, &c.
Pecten.—1. lens (Min. Conch. tab. ccv.)		Commondale, Brandsby, and near Cave, &c.
2. demissus	Pl. VI. fig. 5.	Commondale, Brandsby, Cloughton, White Nab, &c.
3. abjectus	Pl. IX. fig. 37.	Whitwell and coralline oolite.
Lima rudis (Min. Conch. tab. ccxiv.)		White Nab and near Cave.
Ostrea.—1. Marshii (Min. Conch. tab. xlviii.)		White Nab, Commondale, and in other strata.
2. gregarea? (Min. Conch. tab. cxi.)		Westow? and in coralline oolite.
3. sulcifera	fig. 35.	Westow.
4. a small smooth species ...		Cloughton Wyke.
Gryphæa.—1. bullata? or gigantea? (Min. Conch.)		White Nab, (Museum of the Yorkshire Philosophical Society.)
2. a young specimen ...	fig. 26.	Cloughton Wyke.
Terebratula.—1. spinosa (Townshend & Smith.)	fig. 18.	Near Cave and Bath.
2. globata (Min. Conch. tab. ccccxxxv.)		Westow, Whitwell, &c.
3. intermedia (Min. Conch. tab. xv.)		Ditto.
4. large variety of ditto ...		Cloughton, Swainby bank.
Natica adducta	fig. 30.	White Nab, Cloughton, &c.
Turbo muricatus? (Min. Conch.) ...	Pl. IV. fig. 14.	Also in coralline oolite.
Trochus monilitectus	Pl. IX. fig. 33.	Cloughton Wyke.
Delphinula? or variety of the following	fig. 32.	Ditto.
Phasianella cincta	fig. 29.	Cloughton and Brandsby.
Turritella cingenda (Min. Conch.) ...	Pl. XI. fig. 28.	Common in inferior oolite.
Melania.—1. Heddingtonensis (Min. Conch. tab. xxxix.)		White Nab and other strata.
2. striata? (Min. Conch. tab. xlvii.) ...		White Nab, (Mr. Bean.)
Terebra vetusta	Pl. IX. fig. 27.	Cloughton Wyke.

Actæon glaber (Bean, MS.) ...		Pl. IX. fig. 31.	Cloughton and Brandsby.
Rostellaria composita? (Min. Conch.)		fig. 28.	Ditto.
Nautilus (imperfect?)			Brandsby, (a large specimen.)
Belemnites.—1. compressus (Min. Conch. tab. 590; not of Voltz.)		fig. 38.	White Nab, &c.
2. Aalensis (Voltz.)			White Nab, &c.
Ammonites Blagdeni (Min. Conch. tab. cci.)			White Nab.

ANNULOSA.

Vermicularia nodus		Pl. IX. fig. 34.	Westow, Whitwell, &c.
Serpula.—1. lacerata ...		Pl. IV. fig. 35.	Near Scarborough.
2. a quadrate species			

FISHES AND REPTILES.

An imperfect plesiosaurus? was found between the spaw at Scarborough and White Nab, by Mr. Williamson, in 1825.

In the neighbourhood of Brandsby, this rock appears in two separated portions, which have different suites of organic remains. The upper fissile stone strongly assimilates itself to the calcareo-siliceous slaty rock which is quarried on Wittering Heath and at Collyweston, in Northamptonshire, and at Stonesfield, in Oxfordshire, both in respect of its position and its imbedded fossils. This important distinction is less observable in other places, though even where the rock presents but one series of similar layers, those fossils are found on the top which lie in the slaty stone at Brandsby. The most characteristic of these are gervillia acuta, crassina minima, and rostellaria composita? On the contrary, belemnites compressus of Sowerby seems to belong to the lower portion of the rock. It appears to me that the slaty stone, in the Yorkshire district, is of limited and uncertain occurrence, and, from some former investigations in Lincolnshire and Northamptonshire, I suppose it is generally the case. I must defer my remarks on the distribution of the fossils which belong to this rock, till after the catalogue of those in the inferior oolite sand or dogger.

FOSSILS OF THE LOWER CARBONACEOUS SANDSTONE AND SHALE.

THESE consist wholly of the remains of plants belonging to the monocotyledonous families, lycopodineæ, equisetaceæ, filices, cycadeæ, and palmæ, (Sternberg.)

Equisetum.—1. columnare (Brongniart) (Young and Bird, Pl. III. fig. 4, 5, 6 ; Brong. Veg. fossiles, Pl. XIII.)		High Whitby, Stainton cliffs, Haiburn Wyke, Cleveland hills, (Balbronn, Gemonval, Studtgard, &c.)
2. laterale	Pl. X. fig. 13.	Saltwick.
Lycopodites uncifolius	Pl. VIII. fig. 3.	Saltwick and Haiburn Wyke, and in the upper carbonaceous shale.
Thuites expansus ? (Sternberg) ...	Pl. X. fig. 11.	Ditto.
Scolopendrium solitarium	Pl. VIII. fig. 5.	Saltwick, and in the upper carbonaceous shale.
Sphænopteris.—1. muscoides ...	Pl. X. fig. 10.	Saltwick.
2. stipata	fig. 8.	Egton Moors, Saltwick, Haiburn Wyke, and in the upper carbonaceous shale.
? 3. lanceolata ...	fig. 6.	Saltwick.
? 4. undulata (Young and Bird, Pl. I. fig. 3.)		Ditto. ?
Neuropteris.—1. lævigata	fig. 9.	Egton Moors and Haiburn Wyke.
Pecopteris.—1. ligata	Pl. VIII. fig. 14.	Also in the upper carbonaceous shale.
2. curtata	Pl. X. fig. 7.	Egton Moors, and in the upper carbonaceous shale.
Cycadites.—1. latifolius	fig. 1.	Saltwick. Its nervures are very delicate.
2. gramineus	fig. 2.	Saltwick.
3. lanceolatus ...	fig. 3.	
4. pectenoïdes (Sternberg)	fig. 4.	Saltwick, Haiburn Wyke, Cleveland hills.

Flabellaria ? viminea	Pl. X. fig. 12.	Saltwick, and in the upper carbonaceous shale.
Seed of a cycadites ?	fig. 5.	Haiburn Wyke.
Seed vessel.—1. (Young and Bird, Pl. I. fig. 1. on the left)		Saltwick.
2. (Young and Bird, Pl. I. fig. 7.)		Ditto.
3. (Young and Bird, Pl. I. fig. 2.)		Hawsker, in sandstone.

Of the last three specimens, which are in the museum of the Whitby Literary and Philosophical Society, I transmitted drawings to M. A. Brongniart, along with several other representations of species contained in the above list, which were not in the museum of the Yorkshire Philosophical Society, when he examined its contents in 1825.

The above catalogue contains about twenty species of monocotyledonous plants, of which seven appear to me to be identical with as many which have been previously mentioned as occurring above the Cave oolite. One has been found in the slaty stone at Stonesfield; one at Brora, in Sutherland; and in several rocks probably of about the same antiquity on the continent; but *none* in the *more ancient* coal measures associated with the mountain limestone, nor in the *more recent* lignites which belong to strata above the chalk. The result of all accurate inquiries into the nature and distribution of fossil plants, is, that they consist of three great distinct groups of species, which occupy as many peculiar repositories in the series of secondary strata: one group lies above the chalk; another is included between the chalk and the lias; and a third occupies the coal measures and mountain limestone. A cursory observer may, perhaps, be led to confound together the ferns and calamites of the coal district with the ferns and equiseta of the oolitic rocks, though to a botanical eye their difference is very apparent: but who can mistake the lepidodendra of the former, the cycadiform fronds of the middle period, and the dicotyledonous leaves and fruits which abound above the chalk? Many interesting inquiries connected with this subject, as the temperature and condition of the earth, when these plants flourished upon its surface, their inhumation beneath vast deposits of marine shells, and their subsequent conversion to coal of different chemical properties, must here be left unexplored; but I cannot avoid calling the attention of

geologists to the perfect harmony between the distribution of fossil plants and fossils shells. The three great divisions of secondary strata which enclose the three peculiar groups of fossil plants are precisely those which are, in the most decided manner, characterised by the distinct races of molluscous animals which existed during their deposition.

FOSSILS OF THE INFERIOR OOLITE SAND, OR, DOGGER.

Dicotyledonous wood		Cold moor, Blue wick.
ZOOPHYTA AND RADIARIA.		
Caryophyllia convexa	Pl. XI. fig. 1.	Blue wick, Cold moor.
Meandrina		Blue wick.
Cidaris, a plate	fig. 2.	Ditto.
MOLLUSCA.		
Gastrochæna tortuosa (Min. Conch.) ...	Pl. XI. fig. 36.	Blue wick.
Psammobia lævigata	Pl. IV. fig. 5.	Ditto, and other strata.
Mya.—1. calceiformis	Pl. XI. fig. 3.	Ditto.
2. dilata	fig. 4.	Glaizedale (Whitby Mus.)
3. literata (Min. Conch.) ...	Pl. VII. fig. 5.	Cold moor, near Stokesley.
4. æquata	Pl. XI. fig. 12.	Blue wick.
Amphidesma securiforme	Pl. VII. fig. 10.	Glaizedale, Blue wick.
Unio abductus	Pl. XI. fig. 4.	Ditto, &c.
Pholadomya.—1. obliquata ...	Pl. XIII. fig. 15.	Blue wick.
2. fidicula (Min. Conch. tab. ccxxv.)		Ditto.
Pullastra oblita	Pl. XI. fig. 15.	Ditto.
Astarte.—1. elegans (Min. Conch.) ...	fig. 41.	Ditto.
2. minima	Pl. IX. fig. 23.	Ditto, and oolite of Brandsby, &c.
3. a smooth species ...	fig. 10, 11.	Blue wick.
Isocardia.—1. concentrica (Min. Conch.)	Pl. XI. fig. 40.	Ditto, Glaizedale, Cold moor, and oolite of Cave.
2. rostrata (Min. Conch. tab. ccxcv.)		Blue wick.
Cardita similis (Min. Conch.) ...	fig. 39.	Ditto, and other rocks.

Cardium.—1. acutangulum ...	Pl. XI. fig. 6.	Blue wick, Glaizedale, and oolite of Brandsby.
2. incertum	fig. 5.	Blue wick.
3. striatulum (Min. Conch.)	fig. 7.	Ditto.
4. gibberulum	fig. 8.	Ditto.
Lucina	Pl. IX. fig. 8.	Ditto.
Trigonia.—1. striata (Min. Conch.) ...	fig. 38.	Ditto, Glaizedale, and Cold moor.
2. angulata (Min. Conch. tab. dviii.)		Blue wick.
3. costata (Min. Conch. tab. lxxxv.)		Ditto.
Nucula.—1. lachryma (Min. Conch.) ...	Pl. XI. fig. 14.	Ditto, and in oolite of Cloughton.
2. variabilis (Min. Conch.) ...	fig. 19.	Ditto.
3. axiniformis	fig. 13.	Blue wick.
Cucullæa.—1. reticulata (Bean, MS.)	fig. 18.	Ditto.
2. cancellata	fig. 44	Ditto, and in Bath oolite.
Modiola.—1. plicata (Min. Conch. tab. ccxlviii.)		Blue wick, Glaizedalc, and Cold moor.
2. aspera ? (Min. Conch. t. ccxii.) (var. with stronger, smooth striæ)	Pl. XI. fig. 9.	Blue wick.
3. ungulata (Young and Bird, Pl. VII. fig. 10.)		Ditto.
Mytilus cuneatus ... ... compare M. exustus (Lister, tab. 366.)	fig. 21.	Glaizcdale (Mr. Ripley.)
Gervillia lata	fig. 16.	Ditto, and Blue wick.
Lima proboscidea ? (Min. Conch tab. 264.)		Glaizcdale.
Plagiostoma giganteum (Min. Conch. tab. lxxvii.)		Ditto (Mr. Ripley.)
Pecten.—1. abjectus	fig. 37.	Glaizedale.
2. lens (Min. Conch. tab. ccv.)		Glaizedale, and Bluc wick, and in other strata.
3. virguliferus ...	fig. 20.	Blue wick.
Avicula.—1. inæquivalvis (Min. Conch. t. ccxliii.)		Ditto, and in marlstone.
2. Braamburiensis (Min. Conch.)	Pl. VI. fig. 6.	Ditto, and in other strata.
Gryphæa (indeterminable)		Cold moor.
Ostrea solitaria (Min. Conch. tab. ccccIxviii.)		Glaizedale, Bluc wick, and other strata.
Lingula Beanii ... ... (allied to l. mytilloïdes (Min. Conch.)	Pl. XI. fig. 24.	Blue wick.
Terebratula.—1. trilineata (Young and Bird)		Cold moor, Glaizedalc.
(surface striolated)		Ditto.

Terebratula.—2. obsoleta ? (Min. Conch. tab. lxxxiii.)		Glaizedale.
3. bidens ...	Pl. XIII. fig. 24.	Ditto, (Mr. Ripley.)
4. young of intermedia ? (Min. Conch.)		Blue wick.
Orbicula, a large, smooth species (imperfect) ...		Ditto.
Turbo.—1. muricatus (Min. Conch.) ...	Pl. IV. fig. 14.	Ditto, and in coralline oolite.
2. unicarinatus (Bean, MS.)		Blue wick.
3. lævigatus (nerita lævig. Min. Conch.) ...	Pl. XI. fig. 31.	Ditto.
Trochus.—1. bisertus	fig. 27.	Ditto, (Mr. Williamson.)
2. granulatus (Min. Conch. tab. ccxx.)		Ditto.
3. pyramidatus (Bean, MS.)	fig. 22.	Ditto, (Mr. Bean.)
Solarium calix (Bean, MS.) ...	fig. 30.	Blue wick, Cold moor.
Turritella.—1. cingenda (Min. Conch.) right lip spirally undulated within	fig. 28, 29.	Blue wick, (a fine but variable shell.
2. muricata (Min. Conch.)	Pl. IV. fig. 8.	Blue wick, and other strata.
3. quadrivittata ...	Pl. XI. fig. 23.	Blue wick, (rare.)
Melania.—1. Heddingtonensis ? (Min. Conch. tab. xxxix.)		Blue wick.
2. lineata (Min. Conch. tab. ccxviii.)		Ditto, and Somerset.
Natica.—1. tumidula (Bean, MS.) ... (nerita minuta, (Min. Conch. tab. 463.) ?	fig. 25.	Blue wick, and Somersetshire ?
2. adducta	fig. 35.	Blue wick.
Nerita costata (Min. Conch.) ...	fig. 32.	Ditto, and Somerset.
Actæon.—1. glaber	Pl. IX. fig. 31.	Blue wick, and oolite of Cloughton.
2. humeralis	Pl. XI. fig. 34.	Blue wick.
Auricula Sedgvici	fig. 33.	Ditto.
Terebra vetusta	Pl. IX. fig. 27.	Ditto, and oolite of Cloughton.
Rostellaria composita (Min. Conch.) ...	fig. 28.	Ditto.
Nautilus lineatus (Min. Conch. tab. xli.)		Blue wick.
Belemnites (indeterminable) ...		Ditto, and Cold moor.
Ammonites.—1. striatulus (Min. Conch. tab. ccccxxi.)		Blue wick, (rare.)
2. (carinated and radiated)		Ditto.
3. (carinated, flat, involute)		Ditto.

ANNULOSA.

Serpula deplexa (Bean, MS.) ...	Pl. XI. fig. 37.	Blue wick.
Vermicularia compressa (Young & Bird) I cannot distinguish this species from that in the coralline oolite.	fig. 37.	Ditto.

The cornbrash limestone, slaty stone of Brandsby, Cave oolite or gray limestone, and inferior oolite sand or dogger, which together represent in Yorkshire the oolitic formation of Bath, contain a numerous suite of organic remains, agreeing very closely with those obtained from the same strata in other parts of England. Many of these fossils have been observed by Mr. Murchison in the analogous strata of Sutherland, and by Mr. De la Beche and other geologists, in the oolites of Normandy and Switzerland. In the vicinity of Bath, where this formation is the most distinctly exposed, the organic contents of the several strata are extremely similar; and, notwithstanding the valuable labours of Smith, Sowerby, Conybeare, Miller, &c. their zoological characters require further elucidation. The fossils of the middle or great oolite, in particular, are very imperfectly known; and the term "forest marble" has been (I think) applied to very dissimilar members of the series. In the midland counties, the fuller's-earth rock of Mr. Smith does by no means furnish a constant or well-marked line of distinction between the middle, great, or Bath oolite, and the inferior oolite; and I am decidedly of opinion, that in the northern part of Northamptonshire, and throughout Rutland and Lincolnshire, there is but one thick oolitic rock beneath the cornbrash, resting upon brown sandstone which immediately covers the upper lias shale. There is no reason to doubt the identity of the oolites of Lincoln, Cave, Sancton, Westow, and the vicinity of Brandsby and Coxwold; and though we cannot directly trace the connexion across the moorlands, the gray limestone of Sneaton, Hawsker, Cloughton, and White Nab, may be added to the synonyms.

It has been already remarked that the dogger or inferior oolite sand, is a bed of extremely irregular occurrence and varying character, both on the coast and in the fronts of the Cleveland hills; and it cannot, without difficulty, be traced southward in Yorkshire beyond the Derwent. On the hill at Craike, it is a brown sandstone, remarkably similar to that which covers the lias shale near Lincoln, Belvoir Castle, and Uppingham, and no doubt contemporaneous with it. The variable oolitic limestone of Cloughton and Cave is most certainly equæval with the much thicker and finer oolites of Lincolnshire; and the shelly slaty limestone of

Brandsby must be referred to the same place in the series as the analogous beds in Lincolnshire and Northamptonshire. Of this I am perfectly assured by personal investigation. At the time of the first publication of this Work there was not even a doubt expressed by the geologists who had the best opportunities of knowledge, that the Stonesfield slate was superior in position to the great oolite of Bath. Mr. Smith seems indeed to have possessed data which might have led to a contrary conclusion, but it was reserved for Mr. Lonsdale to correct this almost universal error, and to prove that these slaty rocks really belong to the lower part of the great oolite. There is so great an analogy between the slaty rocks of Easton and Collyweston, near Stamford, and those of Stonesfield near Oxford, that it is extremely probable they are of contemporaneous origin. As however some analogous slaty beds do occur above the great oolite of Bath, we must not be too confident on this point, until a survey as accurate and laborious as Mr. Lonsdale's, has cleared up the yet obscure relations of the oolites of Lincolnshire and Oxfordshire. In the meantime I shall use a suitable caution in the application of terms.

The distribution of the organic remains in the 'road-stone,' or slaty rock of Brandsby, Cave oolite, and inferior oolite sand, has yet been carefully ascertained at only a few points; and the following observations will, probably, hereafter receive several corrections. At present, it appears to me that the 'road-stone' is characterized by the great abundance of gervillia acuta, and crassina minima, and by the presence of pholadomya acuticostata, rostellaria composita, and the genus Actæon. Where this rock is united with the middle oolite, as at White Nab, these fossils commonly lie near the top; where it is entirely deficient, (as at Ewe Nab,) they are scarcely to be found. The top of the Cave oolite (as under Gristhorpe cliffs, at Ewe Nab, Owlston, and Ellerker) is generally marked by abundance of millepora straminea, and plates and spines of echini, and columnar joints of pentacrinus caput Medusæ. In the substance of the rock occur belemnites, isocardiæ, pholadomyæ, cucullææ, pernæ, pinnæ, plagiostomæ, pectines, and terebratula. So large a proportion of its organic contents occurs likewise in the inferior oolite sand

beneath, that it is difficult at present to point out what seem to be characteristic. The inferior oolite sand or dogger, on the contrary, besides including a great number of species, which likewise occur in the superior strata, and a few which are repeated in the lias below, is well discriminated by several remarkable fossils. Gastrochæna tortuosa, trigonia striata, gervillia lata, mytilus cuneatus, cucullæa reticulata, lingula Beanii, nerita costata, natica tumidula, (nerita minuta, Min. Conch.) turbo lævigatus, solarium calix, trochus pyramidatus, and trochus bisertus, have not, I believe, been found in any other stratum than the inferior oolite and its accompanying sand, in any part of England.

FOSSILS OF THE LIAS FORMATION.

Wood of dicotyledonous trees, with knots and medullary rays, the external layers often converted to jet, occurs in the upper and lower shales, and more rarely in the intermediate marlstone beds.

Remains of zoophyta are universally of most rare occurrence in the lias, and especially in Yorkshire.

RADIARIA.

Cidaris, a smooth spine ...	... Pl. XIII. fig. 17.	In the marlstone.
Ophiura Milleri ...	... fig. 20.	Staithes, in the marlstone.
Pentacrinus.—1. Medusæ (Miller, Crinoïdea.)		Diffused in the lias, but not abundantly.
2. Briareus (Miller)		Near Redcar.

MOLLUSCA.

Mya literata (Min. Conch.)...	... Pl. VII. fig. 5.	In marlstone, rare.
Sanguinolaria.—1. vetusta	... Pl. XIV. fig. 1.	Marlstone, Rosebury, lower shale, Robin Hood's Bay.
2. elegans	... Pl. XII. fig. 9.	In calcareous nodules (rare.)
Pholadomya obliquata ...	... Pl. XIII. fig. 15.	In marlstone, Bilsdale, Rosebury, &c.
Amphidesma.—1. donaciforme	... Pl. XII. fig. 5.	Upper shale, hard shale, &c.
2. rotundatum	... fig. 6.	Upper shale, and marlstone.

Unio.—1. concinnus (Min. Conch. tab. ccxxiii.)			Upper shale and marlstone.
2. crassiusculus (Min. Conch. tab. clxxxv.)			Near Pocklington.
3. Listeri (Min. Conch. tab. cliv.)			Whitby, upper shale.
4. abductus	Pl. XI.	fig. 42.	In marlstone.
Pullastra prototypa	Pl XIII.	fig. 16.	Ditto.
Venus, as in calcareous grit? ...	Pl. IV.	fig. 26.?	Ditto.
Astarte minima	Pl. IX.	fig. 23.	In calcareous nodules.
Corbis uniformis...	Pl. XII.	fig. 3.	Upper shale, Whitby.
Trigonia literata (Young and Bird) ...	Pl. XIV.	fig. 11.	Lower shale, Robin Hood's Bay; also in the upper shale (Mr. Williamson.)
Corbula? cardioides		fig. 12.	Lower shale, Robin Hood's Bay.
Cardium.—1. truncatum (Min. Conch.)	Pl. XIII.	fig. 14.	Marlstone universally.
2. multicostatum (Bean, MS.)		fig. 21.	In calcareous nodules, and marlstone.
3. cast of inside ...	Pl. XII.	fig. 7.	Upper shale.
Hippopodium ponderosum (Min. Con. t. ccl.)			Lower shale, Robin Hood's Bay.
Modiola.—1. scalprum (M. C. t. ccxlviii.)	Pl. XIV.	fig. 2.	Marlstone, Robin Hood's Bay, Eston Nab.
2. Hillana (Min. Conch. tab. ccxii.)			Robin Hood's Bay.
Pinna folium (Young and Bird, Pl. X. fig. 6.)		fig. 17.	Lower shale, Robin Hood's Bay, Boulby Cliffs.
Nucula.—1. ovum (Min. Conch.) ...	Pl. XII.	fig. 4.	Upper shale, Whitby.
2. complanata (cast) ...		fig. 8.	Ditto.
Cucullæa, a smooth species ...			(Author's cabinet.) From the calcareous nodules.
Crenatula ventricosa (Min. Conch.)			Hard shale, and Hawsker, (Young and Bird.)
Inoceramus dubius var. longitudinally striated (Min. Con. t. ccccxliii.)		fig. 14.	Upper shale, Whitby.
Plagiostoma.—1. giganteum (Min. Conch. tab. lxxvii.)			In marlstone, Staithes, in lower shale, North Cliff,? and Pocklington.
2. pectenoïdeum (Min. Conch.)		fig. 13.	In calcareous nodules.
3. Hermanni (Voltz) var. of ditto?	Pl. XIV.	fig. 18.	Marlstone and calcareous nodules.
Avicula.—1. inæquivalvis (Min. Conch. tab. cclxiii.)		fig. 4.	In marlstone universally.

Avicula.—2. like echinata	...		In calcareous nodules.
3. cygnipes (Young and Bird)		Pl. XIV. fig. 3.	Ditto, Bilsdale, Wilton Castle, &c.
Pecten.—1. sublævis (Young and Bird)		fig. 5.	Abundant in marlstone.
2. equivalvis (Min. Conch. tab. cxxxvi.)			In marlstone and ironstone.
3. lens (Min. Conch. tab. ccv.)			In marlstone, Bilsdale.
4. smooth	... ...		In marlstone, Wilton Castle.
Plicatula spinosa (Min. Conch. tab. cclxv.)		fig. 16.	In lower shale, Huntcliff, Robin Hood's Bay, &c.
Gryphæa.—1. incurva (Min. Conch. tab. cxii.)			Pocklington, Robin Hood's Bay, &c. in lower shale.
2. Maccullochii (Min. Conch. tab. dxlvii.)			In lower shale, Robin Hood's Bay.
3. depressa	... ...	fig. 7.	In marlstone, generally.
Spirifera Walcottii (Min. Conch. tab. ccclxxvii.)			In calcareous nodules (very rare.)
Terebratula.—1. punctata (Min. Conch. tab. xv.)			Marlstone.
2. resupinata (Min. Conch.)		Pl. XIII. fig. 23.	Ironstone, Wilton Castle.
3. trilineata (Young and Bird)			Upper shale, (also in the dogger.)
4. acuta (Min. Conch. tab. cl.)		fig. 25.	Wilton Castle, Bilsdale.
5. bidens (lineata, Young and Bird)		fig. 24.	Wilton Castle, Staithes, Peak, &c. in ironstone and marlstone.
6. triplicata...	...	fig. 22.	Ditto.
7. tetraëdra (Min. Conch. tab. lxxxiii.)			In marlstone and ironstone, generally, also upper shale.
Orbicula reflexa (Min. Conch. tab. dvi.)			From the upper shale at the Peak, and Whitby.
Turbo undulatus	... ...	fig. 18.	In marlstone.
Trochus anglicus (Min. Conch. tab. cxlii.)			Lower shale, Leppington, and Robin Hood's Bay.
Natica, cast of inside	... ...	Pl. XIV. fig. 10.	Lower shale, Robin Hood's Bay.
Actæon	... ...	Pl. XII. fig. 11.	In calcareous nodules.
Rostellaria ?	... ...	fig. 12.	
Nautilus.—1. astacoides (Y. and B.) lineatus? (Min. Conch.)		fig. 16.	Upper shale.
2. annularis	... ...	fig. 18.	Ditto, (Whitby Museum.)

Belemnites.—1.	tubularis (Young & Bird)	Pl. XII. fig. 20.	Upper shale, Saltwick, &c.
2.	compressus (Voltz, Pl. V. but not Min. Conch.)	fig. 21.	Ditto.
3.	trifidus (Voltz, Pl. VII. fig. 3.)		Ditto.
4.	subaduncatus (Voltz, Pl. III. fig. 2.)		Ditto.
5.	conicus (Min. Conch. tab. lx.)		Ditto.
Ammonites.—1.	heterophyllus (Min. Conch.)	Pl. XIII. fig. 2.	Boulby, Whitby.
2.	subcarinatus (Young and Bird)	fig. 3.	Upper shale.
3.	Henleyi (Min. Conch. tab. clxxii.) heptangularis (Young and Bird)		Whitby and Dorsetshire.
4.	heterogeneus (Young&Bird)	Pl. XII. fig. 19.	
5.	crassus (Young and Bird) var. with tubercles	fig. 15.	Upper shale.
6.	communis (Min. Conch. tab. cvii.)		Ditto, generally.
7.	angulatus (Min. Conch. tab. cvii.)		Ditto, rare.
8.	annulatus (Min. Conch. tab. ccxxii.)		In calcareous nodules, near Kettleness.
9.	fibulatus (Min. Conch. tab. ccccvii.)		Upper shale.
10.	subarmatus (Min. Conch. tab. ccccvii.)		Ditto.
11.	maculatus (Young & Bird)	Pl. VIII. fig. 11.	"Hard bands, Hawsker."
12.	gagateus (Young and Bird)		Ditto.
13.	planicostatus (Min. Conch. tab. lxxiii.)		Lower shale, Robin Hood's Bay.
14.	balteatus ...	Pl XII. fig. 17.	Upper shale. (Whitby Museum.)
15.	arcigerens ...	Pl. XIII fig. 9.	Upper shale.
16.	brevispina (Min. Conch. tab. dlvi.)		Lower shale.
17.	Jamesoni (Min. Conch. tab. dlv.)		Ditto, Robin Hood's Bay.
18.	crugatus (Bean, MS.)	fig. 18.	Rare.
19.	fimbriatus (Min. Conch. tab. clxiv.)		Upper shale.
20.	nitidus (Young and Bird)		"Hard bands, Hawsker."
21.	anguliferus ...	fig. 19.	In marlstone bed.
22.	lenticularis ...	Pl. VI. fig. 25.	In ironstone.
23.	crenularis ...	Pl. XII. fig. 22.	In upper shale.
24.	Clevelandicus (Young and Bird)	fig. 6.	Staithes, &c.
25.	Turneri (M. C. t. cccclii.)	Pl. XIV. fig. 14.	Lower shale, Robin Hood's Bay.
26.	geometricus ...	fig. 9.	(Mr. Ripley's collection.)
27.	vittatus (Young & Bird)	Pl. XIII. fig. 1.	In calcareous nodules.

Ammonites.—28.	sigmifer ...	Pl. XIII. fig. 4.	In calcareous nodules.
29.	Hawskerensis (Young & Bird)	fig. 8.	Hard shale and calcareous nodules, Hawsker.
30.	Conybeari (Min. Conch.)	fig. 5.	Nodules and hard shale.
31.	Bucklandi (Min. Conch.)	Pl. XIV. fig. 13.	Lower shale, Robin Hood's Bay, and Redcar.
32.	obtusus (Min. Conch. tab. clxvii.) Redcarensis? (Young and Bird)		Ditto.
33.	Walcottii (Min. Conch. tab. cvi.)		Upper shale.
34.	striatulus (Min. Conch. tab. ccccxxi.)		Ditto, and Peak.
35.	ovatus (Young & Bird)	Pl. XIII. fig. 10.	"Hard bands, Hawsker."
36.	* nitescens (Young and Bird)		"Lias bands."
37.	* obliquatus (Young and Bird)		Ditto.
38.	Mulgravius (Young and Bird)		Upper shale, Lyth, Saltwick, &c.
39.	exaratus (Young and Bird)	fig. 7.	Boulby, &c.
40.	Lythensis (Young and Bird)	fig. 6.	Upper shale, Boulby, &c.
41.	* Boulbiensis (Young and Bird)		Ditto.
42.	* impendens (Young and Bird)		Ditto.
43.	concavus? (Min. Conch. tab. xciv.)		Upper shale.
44.	elegans? (Min. Conch.)	fig. 12.	Ditto.

CRUSTACEA AND ANNULOSA.

Two species of astacus? have been found by Mr. Williamson, in the upper part of the lias shale; one of them strongly resembles that of the Oxford clay; the other is similar to astacus rostratus, Pl. IV. fig. 20.

Serpula capitata...	... ...	Pl. XIV. fig. 6.	Lower shale, Robin Hood's Bay.
Dentalium giganteum	... ...	fig. 8.	Marlstone, common.

REMAINS OF VERTEBRAL ANIMALS.

A large thick fish is rarely found in the lias shale, with solid bony scales. Heads, vertebræ, paddles, and scattered bones of saurian animals have been frequently extracted from the upper shale, and several tolerably complete skeletons have been preserved. There appear to be several species, but farther inquiries must be instituted on

* These ammonites unknown to me, are not figured by the authors who have named them.

this subject. The Museum of the Whitby Philosophical Society contains some of the most valuable of these remains, particularly a small but perfect ichthyosaurus, containing one hundred and thirty-six vertebræ, and a superb crocodile fifteen feet long. Pl. XII. fig. 1, represents the basal surface of a small cranium of a crocodile, to shew the arrangement of the posterior bones, and fig. 2 is a copy of a singular head which seems to differ from any hitherto described ichthyosaurus. A drawing of the full size was given to Baron Cuvier. Both specimens are in the Museum of the Yorkshire Philosophical Society.

The three divisions of the lias formation which have been described on the coast of Yorkshire, may be traced southward through Lincolnshire, Rutland, Northamptonshire, Oxfordshire, Gloucestershire, and Somersetshire. Sections obtained in any part of this long range agree in representing the lias clay, as divided into two portions by an intermediate series of sandy and irony layers of stone, full of many organic remains. The upper division varies in thickness, and changes much in aspect and composition. Its thickness in Yorkshire sometimes equals two hundred feet, and in Rutland exceeds one hundred feet; but in the neighbourhood of Bath may be stated at twenty feet. The marlstone series maintains a general conformity of character, and, though nowhere so thick or so much developed as in Yorkshire, constitutes an important feature in the range of the formation, especially in Rutland. The solid beds of gryphitic limestone which lie toward the base of the lias clay, from Somersetshire to Lincolnshire, may, with attention, be traced in the southern part of Yorkshire, but they nowhere appear on the coast. Mr. Murchison's observations in the district of Brora, and at various points on the western coasts of Scotland, are decisive as to the occurrence of the lias there; but I am unable to determine what particular divisions of the formation are exposed in the several localities. With great deference I beg to suggest that the section of the north-east coast of Skye, (Geological Transactions, New Series, Vol. II. page 360,) would better coincide than it seems to do at present, with the series of the Yorkshire coast, if the following designations should prove correct: No. 1, upper sandstone and shale, (coaly grit of Smith.) 2. Cave oolite

and slaty rock of Brandsby. 3, 4. Lower sandstone and shale with plants. 5. Inferior oolite sand. 6. Upper lias shale, and calcareous nodules, (perhaps attenuated and altered, as happens also in Cleveland.) 7. Marlstone series, resting on the lower shale.

M. Charbant's description of the strata in the vicinity of Lons le Saunier, leaves no doubt of the general conformity of the lias beds, at the base of the Jura limestone, with those of England. (See De la Beche's Geological Memoirs.) Professor Buckland's valuable remarks (Annals of Philosophy, June, 1821) have extended this result to the valleys of the Inn and the Adige: and similar researches prove the continuation of the lias with a large proportion of identical fossils, through Wirtemburg and Franconia. Mr. De la Beche (Geological Transactions, New Series, Vol. I. page 81) has traced the lias on the coast and through the interior of Normandy; it is well developed at the base of the oolites round the central granites of France, and in the country of Metz and Luxemburgh. It seems doubtful whether the marlstone has been clearly recognised by any of the distinguished continental observers, except at Banz near Coburg, where Mr. Murchison has observed it, and as this rock is known to become thinner and less consolidated toward the south of England, perhaps we may infer that it cannot be generally traced on the continent.

So many of the numerous fossils belonging to the lias are peculiar to it, that it seems unnecessary to particularize them. Plagiostoma giganteum is less characteristic of the formation than has been supposed, for it occurs in the inferior oolite and sand both of Yorkshire and Somersetshire. Gryphæa incurva, trochus anglicus, and ammonites Bucklandi appear to be in Yorkshire confined to the lower shale; cardium truncatum, modiola scalprum, pecten æquivalvis, and p. sublævis, avicula inæquivalvis, gryphæa depressa, and terebratula bidens (lineata of Young and Bird) are most abundant in the marlstone and ironstone series, whilst nucula ovum, and amphidesma donaciforme, and the ammonites and belemnites generally, belong to the upper or alum shale, and to calcareous nodules connected with it. The smaller of these

concretions often enclose single ammonites, and the larger ones which lie nearer the ironstone series, are filled with a variety of fossils. Remains of saurian animals have been found in all parts of the formation, but are most abundant in the upper shale.

FOSSILS OF THE DILUVIUM,

IN THE EASTERN PART OF YORKSHIRE.

THE organic remains found in diluvium must be divided into two groups; viz. those which, having been at some former period enclosed in solid strata, were transported from their original sites during a period of watery violence, and those which belonged to animals living immediately before that catastrophe. Of the former kinds, we find on the Yorkshire coast and in the vales of York and Cleveland a great variety, transported in different distances and in different directions. A considerable number of them are described in Mr. Kendall's "Catalogue of Scarborough Minerals and Fossils." Amongst those derived from the mountain limestone of Yorkshire, we may notice a beautiful retepora and a millepora, both nondescript; tubipora strues, *Linn.;* catenipora catenulata, (chain coral,) a beautiful favosites, and several species of astræa, caryophyllia, and turbinolia, besides spiriferæ, productæ, terebratulæ, and crinoïdal columns. From the coal districts of western Yorkshire, we have lepidodendra and variolariæ. But the most abundant diluvial fossils on the coast, are those derived from the lias cliffs in the north; for it is hardly too much to assert that three-fourths of the fossil shells of that stratum may be found in its bouldered fragments between Scarborough and Hornsea. Few of the numerous fossils of the oolitic formations occur in the diluvium, and no belemnites nor inocerami of the chalk have been drifted to the northward, though they are often found in the cliffs of Holderness.

The organic remains of the second group,—viz. of animals which lived on the earth immediately before the flood, are neither so numerous nor so various as the preceding. Those found most generally in the gravel and clay of Yorkshire, consist of the tusks and molar teeth of elephant, and teeth and bones of horse, ox, and deer. But the osseous remains of many other animals were found in the celebrated cave of Kirkdale, near Kirbymoorside, so well preserved as to allow of their species being perfectly determined; and a more recent discovery of equal geological interest in the vale of York, has greatly extended our knowledge of the animals which preceded man in the occupation of the ancient surface of Yorkshire.

KIRKDALE CAVE.

The interesting phenomena of Kirkdale cave have been so ably unfolded by Dr. Buckland in his 'Reliquiæ Diluvianæ,' that I determined from the first to refer to that admirable work for descriptions and figures, which could not be introduced into mine without greatly enhancing the price. I was, therefore, unable to avail myself of the generous offer of Mr. Salmond to supply me with original information from his own valuable and instructive description of the cave which he explored with so much zeal and success.

The teeth and bones discovered in this cave belong to the following species of animals;

7. Carnivora; hyæna, tiger, bear, wolf, fox, weasel, and, according to Mr. Salmond, lion.

4. Pachydermata; elephant, rhinoceros, hippopotamus, and horse.

4. Ruminantia; ox, and three species of deer.

4. Rodentia; hare, rabbit, water-rat, and mouse.

5. Birds; raven, pigeon, lark, duck, and partridge.

The floor of the cave was covered with sandy mud; on this lay an irregular deposit of stalagmite, produced by droppings from the roof

which was studded with pendent stalactite, and by currents down the sides of the cavity, which were also partially lined with the same calcarcous incrustation. The bones lay dispersed in the mud and in the stalagmitic crust, broken into angular fragments and chips, but "not bearing the least appearance of having been rolled in water: nor was a single pebble found in the cave." The fractures appeared all to have been occasioned by violence, and many of the fragments were marked with impressions, such as a living hyæna has been found to imprint on similar bones submitted to his powerful jaws. These circumstances, combined with the evidence derived from the album græcum, and the extraordinary number of teeth of hyænas, in every condition from that of the milk-tooth to the aged grinder worn to the gums by mastication, seem to fully justify Dr. Buckland's opinion that this was a den of hyænas who dragged into it piecemeal the other animals, for food.

The quantity of the reliquiæ seems to shew that the cave was tenanted for a long succession of years; and a comparison of these remains with others found in diluvial gravel, determines that they belong to the same extinct species. As there is no evidence that such animals have existed in this country (or, indeed, in any part of the world) at subsequent periods, the only conclusion at present tenable is that the cave was an antediluvian den, of the same nature as Kent's hole, and the bear caves of Franconia. We must, therefore, admit that in those early periods, this country was inhabited by a variety of animals which now dwell only in tropical regions, and the question of its ancient condition is answered in one of its terms. We may further infer, that, since its inhabitants were analogous to those that now exist, its surface had the same general characters; forests for the stag and the elephant, lakes for the rhinoceros and the hippopotamus, and rocky coverts for the prowling hyæna. These animals might be fitted by constitution to support the rigours of a northern climate; but the general harmony of geological phenomena seems to be better preserved by admitting that the northern regions of the earth were something warmer when they existed here than at present. Additional evidence on this subject is afforded in the following pages.

BIELBECKS.

THE diluvial accumulations which cover the red sandstone deposit in the vale of York, consist generally of great quantities of gravel and fragments of rocks derived from the west and north-west of Yorkshire, intermixed with others from the Cumbrian mountains. The relative proportion of stones derived from the latter source increases from York northward, so that in the gravel near Easingwold, Thirsk, North Allerton, and Stokesley, a great variety of specimens of rocks may be collected, such as occur about Grasmere, and Patterdale, Kirby Stephen, Shap fells, Carrock fell, and High Pike. There is to be observed, generally, in the vale of York a distinction of the diluvial deposits into three kinds,—one argillaceous and holding a larger proportion of pebbles and slightly worn fragments of rocks brought from very distant sources; another a sandy and gravelly deposit in which masses of sandstone and limestone from the western regions are more predominant; the third a mass of rounded chalk and angular flint. Near York, and along the line of country to the N. West, the gravel consists principally of sandstones and limestones from the western hills; sometimes sandstone occurs almost alone (Ouseburn): sometimes a mixture of sandstone, limestone, basalt, granite of Shap, &c. (near Boroughbridge.) As we proceed toward Doncaster, and the vale of the Trent, the diluvium consists of materials from the west, and is found to contain very few traces of that impulse which brought the Cumbrian rocks over Stainmoor, and spread them across the whole N. E. of Yorkshire, and along the coast of Holderness. The numerous excavations for the roads have laid open the second sort of accumulation more frequently and completely than the others, and a considerable number of bones and teeth of the elephant, rhinoceros, large ox, deer, horse, &c. have been discovered in it. The elevation of the undulated ground formed by diluvial accumulations in the middle of the vale of York is inconsiderable, seldom exceeding 70 or 100 feet; but portions of similar deposits rest on higher points toward the Hambletons, and lie on high valleys of the wolds (as at Middleton.)

In some places (Sandburn near York, Ouseburn, &c.) indications of lacustrine deposits may be observed resting on the diluvial accumulations, and containing wood, fresh-water shells, &c. as in Holderness, so that there can be no doubt of the similarity and, geologically speaking, contemporaneity of origin of all the deposits classed as diluvial in the northern and eastern parts of Yorkshire. Along the western base of the chalk wolds, about Pocklington, Market Weighton, &c. are limited breadths of the third sort of gravel deposit, consisting of chalk and flint spreading over the lias and new red sandstone deposit, and apparently due to local though very powerful currents, but whether contemporaneous with those which laid the similar gravel amidst the ordinary diluvium of Holderness, (page 39) or beneath it at Hessle, is difficult to pronounce. On the sea-coast near Bridlington several situations have been noted, which shew the diluvial currents to have been of some duration, subject to vary in impetus and direction, and to be interrupted at intervals of at least local tranquillity. In such a period of partial tranquillity, we may believe the laminated clays at Ouseburn, and Kilnsea to have been deposited, and a more interesting discovery of the same nature in the vale of York in 1829, appears to indicate that such intervals in the diluvial period may hereafter become distinctly characterized by peculiar deposits and contribute to correct the general history of the diluvial formation.

The merit of first calling attention to the ossiferous marl deposit of Bielbecks near Market Weighton, belongs in a great degree to Mr. William Hey Dikes of Hull, who after a careful study of the circumstances of this deposit, favoured me with the information which he had collected. I lost no time in proposing to my friends, the Rev. W. V. Harcourt and Mr. Salmond, an excursion to the locality, and our joint communication on the subject was inserted in the Philosophical Magazine for Sept. 1829. Subsequently the great importance of the facts connected with this discovery, induced the Council of the Yorkshire Philosophical Society to continue for the advantage of science the excavations which the farmer had originally made for agricultural purposes; and a great number of additional bones were discovered;

the geological circumstances connected with them were fully ascertained; and made public by a second memoir of Mr. Harcourt, (Philosophical Magazine, 1830.) The whole collection of bones, and many of the accompanying shells, &c. were subsequently placed in the Yorkshire museum by the liberality of the proprietor of the land, W. Worsley, Esq. of Hovingham, and there this unique collection is very carefully labelled and arranged.

The following is an epitome of the facts observed and recorded. The Market Weighton canal passes through a part of those extensive levels or flat alluvial tracts which border the tide rivers of Yorkshire, and consist of silt deposited by the tides and freshes, variously interspersed with tracts of peat moor, and accumulations of timber, and divided by insular hills and ranges of 'hard land.' From the Humber to the country near North Cliff, Market Weighton, and Holme, no exposure of stratified rocks is any where observed, nor any very obvious indication of diluvial accumulations. The south-eastward base of the gravel hill of Holme shews red marl and gypsum, the lower part of the lias appears at North Cliff, three miles to the east, and the intermediate country is nearly an unbroken flat, a few feet above high-water in the Humber, of sand, peat, and silt land,—with an irregular border of chalk and flint and other gravel on the east, constituting the very low talus of the lias range of North Cliff and Hotham. That nearly the whole is underlaid by the red marl and gypsum is evident by the exposure of these substances in the Market Weighton canal, and by the observations to be noticed.

Two miles south of Market Weighton, and one mile north-west of North Cliff, at the edge of a sandy and gravelly warren, in the eastern part of the broad level above described, is the solitary farm-house of Bielbecks, belonging to Wm. Worsley, Esq. The tenant, Mr. Foster, desirous of improving the poor sand land near the house, opened a considerable deposit of argillaceous marl, and spread it in great quantities on his fields.

The excavation presented the following section above the water.

	Ft.	In.
1. Black sand at the surface	0	9
2. Yellow sand	1	6
3. White gravel, consisting of small pebbles of chalk and angular fragments of flint, with a few pieces of gryphæa incurva and finer pebbles of sandstone, varying in thickness, average ...	2	6
4. Blue marl irregularly penetrated by the gravel, No. 3, and partially chequered by it	5	0
5. Commencement of a blacker marl which had been excavated to a depth of ten feet, and contained most of the bones and shells.		

Under the direction of Mr. Harcourt, another pit was opened; six or seven hundred loads of marl were removed; the deposit was penetrated to its lowest bed; the depth at which the several bones were found was measured; and the nature and the location of all the contents of the pit were carefully observed. The following Table drawn up by Mr. Harcourt contains the chief details of this examination.

MINERAL CONTENTS.	Depth in Feet.	ORGANIC CONTENTS.
Yellow sand. In this and the gravel below it a few pebbles of quartz and sandstone.	3	No bones, shells, or vegetable remains in the sand or gravel.
Gravel composed of chalk pebbles, and sharp flints.	$4\frac{1}{2}$	
Gray marl indented by the gravel in some places to the depth of three feet, and containing rolled pebbles of quartz, mountain limestone, and sandstone of the carboniferous series, with chalk and flint.	10	No shells or vegetable remains in the gray marl. At 7 ft. *Elephas primigenius.* Numerous small fragments of the tusk and and teeth. 8 Calcaneum of ditto. 9 Three cervical vertebræ of ditto. 10 Astragalus of ditto; radius of *horse*, lower end; radius of *rhinoceros*, upper end; branch of horn of *deer*.
Black marl, containing minute pebbles of chalk, very few flints; at the bottom two or three pieces of a fine-grained calcareous sandstone, similar specimens to which may be found in one of the adjacent beds of the red marl series; no fragments derived from remote districts.	$22\frac{1}{2}$	11 *Bison.* Metatarsal bone. *Wolf.* Radius. $12\frac{1}{2}$ *Elephant.* Humerus, and the head of it detached. 13 *Horse.* First Phalangal bone. $13\frac{1}{2}$ *Ditto.* Second ditto. 14 *Ditto.* Third, (with Helix memoralis.) *Elephant.* Four caudal vertebræ. *Duck.* Ulna, clavicle, tibiæ. 15 *Bison.* Occiput, horns, and part of the frontal and maxillary bones. *Wolf.* The right lower jaw, and condyle of the other; *right humerus, radius, and ulna articulating.* 18 *Bison.* Two molar teeth of the upper jaw. The black marl abounds in shells; chiefly planorbis complanatus, and limnea palustris; and in vegetable remains including jointed stems. *Horse.* A rib.
Strong blue marl. Some clay nodules in this. *Flint gravel in marl.* *Strong blue marl.* *Flint gravel in marl.*		No bones, shells, or vegetable remains in these alternations.

RED MARL the basis of the whole deposit.

The basin of red marl in which this lacustrine deposit is formed is very limited, only a few hundred yards long from east to west, and not so much from north to south; the black ossiferous and shelly marl appears by Mr. Harcourt's borings to be in one place only about 50 or 60 yards across in the direction from north to south. About a quarter of a mile to the east is another marl deposit, covered by five or six feet of chalk and flint gravel; half a mile further in the same direction is another consisting of a stronger blue clay, in which much undecomposed *shale* may be observed, enveloping in its upper part *boulders* of the chalk, blue oolite, and lias of the neighbouring hills.

Condition of the bones. Among the numerous specimens of bones very few shewed the least mark of mechanical attrition, or chemical decomposition; in general they were perfectly preserved, and many of them entire; such as were broken shewed uninjured surfaces and angles of fracture. On *the ends* and edges of two of the broken bones, there was a high polish; a peculiar corrosion into little pits was observed on one or two fragments: the epiphyses of the vertebræ of the elephant (it being a young individual) were found nearly in their relative place, and the same remark applies to the metatarsal and phalangal bones of the horse, and to the leg bones of the wolf. Upon the whole nothing can be more certain than that the bones in the black marl were inhumed only a very small distance from the place where the animals died, that they had not been subject to the ravenous jaws of hyænas, nor been transported from any earlier deposit.

The following species of animals were recognised.

Remains of Quadrupeds. These were found both in the black marl and in the superior marly gravel deposits.

Elephant ... ... (Elephas primigenius Blum). Tusk, teeth, humerus, and vertebræ.

Rhinoceros tichorhinus ... Teeth, tibiæ, rib?

Bos urus antiquus ... Cranium and horns, teeth, vertebræ, bones of the legs and feet. Parts of two individuals were recognized.

Stag of great size ... ... Portions of horn and metatarsal bone.
Horse of large size ... ... Metatarsal and phalangal bones of the hind leg.
Felis spelæa ... ... Lower jaw; part of upper jaw; femur, radius, ulna, and metacarpal bones.
Wolf ... ... Humerus, radius, and ulna of right side; right lower jaw; condyle of the other.
BIRDS: *Duck* ... ... Ulna, clavicle, tibia.
INSECTS. ... ... The green elytron of a species of chrysomela.
MOLLUSCA. ... ... The remains of this class were numerous in the black marl, but did not occur in any other member of the deposit. They consisted of thirteen species, all identical with living types procured in the neighbouring country: viz.
Three TERRESTRIAL SHELLS. *Helix nemoralis*, four specimens marked with coloured bands; the rufous tint though faded is still distinguishable. On three of them are three bands on the upper whorls, on the other two.

Helix caperata, two specimens.

Pupa marginata, three specimens.

One SWAMP SHELL. ... *Succinea amphibia Drap*, three specimens.
Nine FRESH-WATER SHELLS. *Limnea limosa*, one specimen.

palustris, fifteen specimens, varying like the recent examples in proportion and degree of smoothness, but never bevilled in the upper part of the volution; the twist on the pillar lip is perhaps a little more decided and prominent. There is one specimen of a very remarkable variety shaped like L. longiscata of Lamarck, but marked with facets like the other specimens of L. palustris.

Planorbis complanatus, twenty-three specimens. I can find no other difference between these, and those now living near York, than the rather more frequent occurrence of spiral striæ across the lines of growth. The same varieties as to flatness of the whorls and position of the keel as in fresh specimens.

Planorbis vortex, one.

contortus, two.

nitidus.

spirorbis, one.

Valvata cristata, one.

Pisiduim amnicum, five.

The shells are all white, never compressed, not particularly tender, and very entire. The black marl which contains them is not laminated; nor are the shells arranged in it in any peculiar order or position, but lay mixed with bones from top to bottom indifferently. It was doubtless deposited beneath the waters of a marshy pool, which nourished the planorbes, limneæ, &c., and received by some little streamlet, or occasional inundations, the helices from the land, and succineæ from the adjoining plants. The elephant, rhinoceros, and other animals died near the lake or the stream, and their partly disintegrated remains were washed by the same forces into the same repository, or brought thither at a later period, along with abundance of marl and gravel attesting the operation of a powerful and considerable current of water. By these latter accumulations the lake was filled to the level of the surrounding surface.

In this lacustrine deposit of the elephantoïdal or antediluvial æra, are observed facts of great value towards elucidating some material points regarding the early condition of Yorkshire.

First—Since all or nearly all the mass of clay and marl, and chalk and flint gravel, may be reasonably admitted to have been brought from the neighbouring low ranges of lias, and the surface of the wolds, there is nothing to indicate the operation of floods of extraordinary power or extent, except the presence of some pebbles of limestone and sandstone derived from the western hills, which lie in the upper parts of the deposit. These are few in number compared to the mass of flint and chalk gravel, and, though requiring the admission of the flowing of antediluvial rivers or other currents from the west, do not demand for the explanation of their accumulation *here,* more than the action of such limited floods or inundations as might deposit the rest of the gravel. Such inundations were frequent *before* the deposition of the ossiferous marl, and were repeated at a later period; and it appears to be proved both by comparison with the analogous deposits at Hessle and Bridlington, and by the superposition of the ordinary diluvium in the south-eastern part of the vale of York, that the *latest* of these inundations was *anterior* to the movement of waters which brought many Cumbrian rocks

through the pass of Stainmoor, and dispersed them over the hills and valleys and antediluvial lake deposits of Yorkshire. *How long anterior* is not the question—the order of succession of the events is all that we are now concerned with.

Secondly—It follows from what has been stated, as to the limited nature of the agencies concerned, that the quadrupedal, molluscous, and other remains, are those of animals then living in the vicinity; and this conclusion is most amply confirmed by the condition of these reliquiæ. This important truth, no longer depending solely on the evidence, however satisfactory, in Kirkdale cave, but attested by new witnesses, may be definitively admitted; and we are enabled to clear those parts of geological theory which relate to comparatively recent operations on the surface of some objections, and to propose a precise and logical argument concerning the ancient condition of Yorkshire.

We may be sure that the leading geographical features of the south-eastern parts of the county are of higher antiquity than the date of the diluvial floods. Though certainly particular tracts were greatly devastated by these waters, and their wasted materials carried in a strange manner to great distances, the physical aspect of this particular region was only modified in a slight degree, the fundamental features of hill and valley were unchanged, the course of drainage was little affected, the races of aquatic animals were not destroyed; the devastation passed, and with it apparently perished the larger and heavier quadrupeds of the marshes and plains, but many races survived to perish in later days by natural changes or man's persecution,—inhumed in similar lakes with similar shells, in various parts of the county.

The question of ancient climate receives from this investigation new and independent data. While from the general *analogies* of form between the fossil and recent elephant, rhinoceros, hippopotamus, felis, and hyæna, the mind was influenced by a vague notion that the climate of the northern zones was formerly of a tropical character, the equally strong analogies of the urus, glutton, beaver, wolf, deer, &c. restored the

balance of opinion; and geologists were not justified in coming to a positive conclusion. But the occurrence with the elephant and rhinoceros, of thirteen species of land and fresh-water shells precisely *identical* with existing types from the neighbouring pools and ditches, must be allowed to give more exact and satisfactory evidence. Such a group of molluscous animals, does not exist together except in a small range of latitude, to the north or south of England. Before arriving at the parallel of 60° N. many of the species are lost; others vanish and are replaced by new forms before we touch the shores of the Mediterranean; such then are the limits within which speculations as to the ancient climate of the northern regions once tenanted by the elephant and rhinoceros, must be restrained; and those who recollect the hairy covering of the individuals of these genera found on the shores of the Arctic Sea, will probably supply for themselves the obvious conclusion, that these animals were fitted by a peculiarity of constitution to support at least the occasional rigours of a temperate climate.

Existing species of fresh-water shells, occurring in connexion with extinct fossil quadrupeds, have been noticed by Mr. Hugh E. Strickland, under beds of gravel near Cropthorne in Worcestershire; they occur abundantly in an ancient lacustrine deposit near Weimar, and it is probable that future research will greatly augment the mass of facts bearing on this subject. The ossiferous deposits in Val d'Arno may perhaps belong to this period.

SYNOPTIC TABLE OF THE FOSSILS

IN THE

STRATA OF THE YORKSHIRE COAST

ARRANGED ACCORDING TO THEIR NATURAL AFFINITIES, WITH NOTICES OF THE STRATA IN WHICH EACH SPECIES OCCURS.

NOTE.—The names of the species not mentioned in the preceding pages are in Italics. The strata in which the species occur are indicated by numbers referring to pages 2, 3, of this Edition, and to pages 32, 33, of the First Edition.

The species to which this * mark is affixed will be figured in Supplemental Plates destined by the Author to include these and other new species.

ABBREVIATIONS used.—B. for Brongniart, Geologie des Environs de Paris. A. B. Adolphe Brongniart, Histoire des Vegetaux Fossiles. S. for Sowerby. V. Voltz. L. and H. Lindley and Hutton. Y. and B. Young and Bird. P. Phillips. Park. Parkinson. G. Goldfuss. M. Mantell. M. C. Mineral Conchology.

REMAINS OF PLANTS.

Names in this work.	*Figures in this work.*	*Synonyms and References.*	*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
CRYPTOGAMIA.				
Lycopodites.—1. uncifolius, P. ...	viii. 1, 3	L. Williamsonis, A. B. ...	11, 13	
2. *falcatus* ...	...	L. falcatus, L. and H. t. 61 ...	13	
Equisetum.—1. columnare, A. B. ...	...	Veg. Foss. t. 61 ...	11, 13	Ool. Ser. Brora, Balbronn, Stutgard, &c.
2. laterale, P. ...	x. 13	... ...	13	
Scolopendrium solitarium, P. ...	viii. 5	Tæniopteris vittata, A. B. t. 82	11, 13	Lias sandstone, Hör, Neuewelt near Basle, Stonesfield.
Tæniopteris latifolia, A. B. ...	...	Tæniopteris major. L. & H. t. 92	11	
Sphænopteris.—1. ? latifolia, P. ...	vii. 18	Cyclopteris digitata, A. B. t. 61	11	
2. ? longifolia, P. ...	vii. 17	... ...	11	
3. digitata, P. ...	viii. 6	Sph. Williamsonis, A. B. t. 49	11	
4. stipata, P. ...	x. 8	Sph. hymenophylloides, A. B. t. 56	11, 13	
5. *denticulata*, A. B. ...	...	Veg. Foss. t. 56 ...		
6. *crenulata*, A. B. ...	...	Veg. Foss. t. 56 ...	13	
7. muscoides, P. ...	x. 10	... ...	13	

Names in this work.		Figures in this work.	Synonyms and References.	Strata in which the species occurs in Yorksh.	Other localities for the species.
Sphænopteris.—8. ? lanceolata, P.	...	x. 6	Pachypteris lanceolata, A. B. t. 45	13	
9. ? undulata, P.	...	...	Y. and B. t. 2, f. 3 (Ed. 1) ...	13	
* 10. microphylla, P., MS.	...	...	My cabinet ...	13	
Neuropteris.—1. lobifolia, P.	...	viii. 13	... ...	11, 13	
2. *undulata*, L. and H.	...	...	Foss. Flor. t. 83 ...	11, 13	
3. *arguta*, L. and H.	..	...	Ditto t. 105		
4. ? lævigata, P.	...	x. 9	Pachypteris ovata, A. B. t. 45	13	
Pecopteris.—1. paucifolia, P. †	...	viii. 8	Glossopteris Phillipsii, A. B. t. 61, and t. 63	11	
2. recentior, P.	...	viii. 15	Neurop. recentior, L. and H. t. 68	11	
3. exilis, P.	...	viii. 16	... ...	11	
4. crenifolia, P.	...	viii. 11	Pecopt. propinqua, L. & H. t. 119	11	
5. hastata, P.	...	viii. 17	Pecopt. tenuis, A. B. ...	11	Bornholm.
6. curtata, P.	...	viii. 12, x. 7	Pecopt. Williamsonis, A. B. t. 110	11	
7. cæspitosa, P.	...	viii. 10	... ...	11	
8. ligata, P.	...	viii. 14	Pecopt. Whitbiensis, L. and H. t. 134	11, 13	
9. *Whitbiensis*, A. B.	...	...	Veg. Foss. t. 109 ...	11, 13	Collyweston.
10. *denticulata*, A. B.	...	...	{ Ditto t. 98 / Neuropt. ligata, L. & H. t. 69. }	11	
11. *insignis*, L. and H.	...	...	Foss. Flor. t. 106 ...	11	
12. *Phillipsii*, A. B.	...	...	Veg. Foss. t. 109 ...	13	
13. *polypodioides*, A. B.	...	...	Foss. Flor. t. 60 ...	11	
14. *undans*, L. and H.	...	...	Ditto t. 120 ...	11	
Phlebopteris contigua, L. and H.	...	...	Ditto t. 144 ...	11	
PHANEROGAMIA.					
Cycadites.—1. latifolius, P.	...	x. 1	Otopteris, L. and H. ...	13	
2. gramineus, P.	...	x. 2	Zamia, A. B. ...	13	
3. lanceolatus, P.	...	x. 3	Ditto ...	12, 13	
4. comptus, P.	...	vii. 20	Pterophyllum comptum L. & H.	11	
5. tenuicaulis, P.	...	vii. 19	... ...	11	
6. sulcicaulis, P.	...	vii. 21, a, b, c	Ctenis falcata, L and H.	11	
7. pecten, P.	...	vii. 22	Pterophyllum pecten, L. & H.	11	Seyssel.

X

† The figure of this plant on Pl. VIII. has been drawn with great care; on one of the leaves the nervures are expressed with a considerable approach to accuracy. The others give the ordinary aspect of the surface. The specimen figured by Lindley and Hutton, t. 63, has broader leaves and a more complicated interneuration, which however is not exactly represented in the drawing.

Names in this work.		Figures in this work.	Synonyms and References.	Strata in which the species occurs in Yorksh.	Other localities for the species.
Cycadites.—8. pectinoides, P.	...	x. 4	(Polypodiolites pectiniformis? S. t. 33)	13	Stonesfield.
(Aspleni-opteris) 9. Nilsoni, P.	...	viii. 4	PterophyllumNilsoni? L. & H.	11	
Pterophyllum minus, L. and H.	...	...	Foss. Flor. t. 67 ...	11	
Otopteris.—1. *Beanii*, L. and H.	...	...	Ditto t. 44 ...	11	
2. *acuminata*, L. and H.	...	...	Ditto t. 132 ...	11	
Winged seed (of Cycas?)	...	viii. 2, x. 5	... ...	13	
Seed vessel	...	...	Y. and B. t. 1, f. 1 ...	13	
Ditto	...	...	Ditto t. 1, f. 7 ...	13	
Ditto	...	...	Ditto t. 1, f. 2 ...	13	
Fruit of a palm.	...	...	Ditto t. 1, f. 5 (Edit. 2) ...	6	
Coniferous wood	...	...	Witham on Fossil Vegetables	3 to 17	
UNKNOWN TRIBES.					
Leaves, seeds, &c.	...	vii. 23, 24, 25			
Flabellaria viminea, P.	...	x. 12	Solenites Murrayana, L. & H. t. 121	11, 13	
Phyllites nervulous, P.	...	viii. 9	Dictyophyllum rugosum, L. and H. t. 104	11	
Thuytes expansa, P.	...	x. 11	Sternberg, xxxviii. 1, 2?	13	Stonesfield, Collyweston.

REMAINS OF ZOOPHYTA.

Names in this work.		Figures in this work.	Synonyms and References.	Strata in which the species occurs in Yorksh.	Other localities for the species.
FIBROSA.					
Spongia.—1. plana, P.	...	i. 1			
fungiform. 2. capitata, α. P.	...	i. 2			
3. ——— β.?	...	...			
4. osculifera, P.	...	i. 3			
5. Benettiæ, Mant.	...	i. 4	Ventriculites Benettiæ	...	Sussex, Kent, Wilts, &c.
6. verrucifera, P.	...	...		1	
7. convoluta, P.	...	i. 6			
8. marginata, P.	...	i. 5			
fistuliform. 9. radiciformis, P.	...	i. 9			
10. terebrata, P.	...	i. 10			

Names in this work.		*Figures in this work.*	*Synonyms and References.*		*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
Spongia.— funnel shaped. 11. porosa, P.	...	i. 8	...	...	...	Dover.
12. lævis, P	...	i. 8, a	...	...	...	Ditto.
13. alcyonoides, P.	...	...	Ventriculites alcyonoides, Smith, Strat. ident. fig. 1		1	Sussex, Kent, Wilts, &c.
14. cribrosa, P.	...	i. 7	...	...	...	Sussex, Wilts, Kent, &c.
ramose. 15. ramosa, Mant.	...	...	Fossils of the South Downs, t. 15, fig. 11			
16. floriceps, P.	...	iii. 8	...	...	6	
other species	...	...	...	...	6, 1	
CELLULIFERA.						
Cellaria Smithii, P.	...	vii. 8	...	...	10	Near Bath.
Cellepora	...	...	...	...	11	
Millepora.—1. straminea, P.	...	ix. 1	...	...	12	
2. globularis, P.	..	i. 12	...	...	1	
Lunulites urceolata, Mant.	...	i. 11	...	...	1	Sussex.
Retepora? P.	...	ix. 2	...	...	12	
LAMELLIFERA.						
Turbinolia dispar, P.	...	iii. 4	...	...	6	Bottisham.
Caryophyllia.—1. conulus, P.	...	ii. 1.	...	...	2	Sussex, Wilts.
2. centralis, M.	. .	i. 13	Mantell, t. 16, figs. 2, 4	...	1	
3. cylindrica, P.	...	iii. 5	...	...	6	
4. convexa, P.	..	xi. i	...	...	14	Wilts, Berks.
5. like cæspitosa, P.	...	...	...	...	6	Ditto.
6. like flexuosa, P.	...	...	...	..	6	Oxon, Berks., Wilts, &c.
Astræa.—1. favosioides, P.	...	iii. 7	Smith, Strat. ident.	...	...	
2. inæqualis, P.	...	...	...	...	6	
3. micrastron, P.	...	...	...	...	...	Wilts.
4. arachnoides, Flem., Park.	...	...	Org. Rem. ii. 6, 4	...	...	Ditto, Franconia.
5. tubulifera, P.	...	iii. 6	a. tubulosa? Goldfuss.	...	14, 6	
other species	...	...	...	...	6	Wilts.
Meandrina	...	...	...	...		
TUBULIFERA.						
Tubipora or Eunomia?	...	...	...	...	12	Near Bath.

REMAINS OF RADIARIA.

Names in this work.	*Figures in this work.*	*Synonyms and References.*	*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
STELLERIDA.				
Ophiura Milleri, P. ...	xiii. 20	... ...	16	
CRINOIDEA.				
Pentacrinus.—1. Caput Medusæ, Mill. ...	...	Crinoidea ...	17,16,15,&c.	South of England, Alsace.
2. Briareus, Mill. ...	...	... ...	17, 16, 15	Ditto, Wurtemburgh.
Unknown genus.—1. ...	iii. 9, 10	Rhodocrinus echinatus, G.	6	Sternberg, Switzerland.
2. ...	iii. 11	... ...	6	
Crinoidal Column ...	...	... ...	3	
Apiocrinus ellipticus, Mill. ...	...	Crinoidea, Mantell t. 16, f. 6	1	South of England, &c.
Marsupites ornatus, Mill. ...	i. 14	... ...	1	Kent, Sussex, &c.
ECHINIDA.				
Cidaris.—1. papillata, Auct. ...	i. 14 a	O. R. iii. t. 4, f. 9 (C. cretosa)	1	Kent, Sussex.
2. florigemma, P. ...	iii. 12	C. coronatus, &c. et C. Blumenbachii, G.	6	Wilts, Switzerland, Germany.
3. intermedia, Flem. ...	...	O. R. iii. 4,20, C. crenularis, G.	6	Ditto.
4. monilipora, P. ...	...	Y. and B. t. 6, f. 3, *(imperfect)*	6	
5. vagans, P. ...	vii. 1	... ...	7, 10, 12	South of England oolites.
6. maxima, G. ...	ix. 5	Goldfuss, xxxix. 1 ...	12	Baireuth, &c.
other species ...	...	... ...	2, 12, 14, 16	
Echinus.—1. germinans, P. ...	iii. 15	See Goldfuss, t. 40. fig. 12 ...	6, 7, 12	Switzerland.
2. Königi, M. ...	...	Cidaris granulosus, Goldf. Org. Rem. iii. Pl. i. fig. 10	1	
Clypeus † *ambulacra poroso-striate*				
1. sulcatus, Leske	...	Org. Rem. iii. 2, 1 ...	6	Switzerland.
2. emarginatus, P.	iii. 18	... ...	6	
†† *Ambulacra biporous*				
3. semisulcatus, P.	iii. 17	... ...	6, 12	
4. dimidiatus, P. ...	iii. 16	*Nucleolites scutatus*, G. ...	6	Oxon, Wilts, Pappenheim, Monheim.
5. clunicularis, Llwyd	vii. 2	... ...	6, 7, 10, 12	South of England oolites.
6. orbicularis, P. ...	vii. 3	... ...	10	
Galerites.—1. albogalerus, Lam. ...	...	Mantell, xvii. 8 ...	1	South of England, France.
2. subrotundus, M. ...	...	Ditto, t. 17, 16, 18 ...	1	Ditto.
3. depressus, Lam. ...	vii. 4	Goldfuss, t. 41, f. 3 ...	6, 7, 10	Oolites, South of England, Schaffhausen.
Clypeaster pentagonalis, P. ...	iv. 24	... ...	7	Near Bath.
Spatangus.—1. cor anguinum, B. ...	...	Env. de Paris, t. 4, fig. 11 ...	1	South of England, France, &c.

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ECHINIDA.				
Spatangus.—2. planus, M. ...	i. 15	... ...	1	Kent, Sussex.
3. hemisphæricus, P. ...	i. 16	... ...	2	Kent, Sussex, Wilts, Westphalia.
4. ovalis, Park. ...	iv. 23	... ...	6, 7, 9	Besançon, Switzerland.
5. argillaccus, P. ...	ii. 4	... ...	..	Wilts, Sussex ?
Ananchytes.—1. ovatus, Lam. ...	...	Env. de Paris, t. 5, fig. 7 ...	1	South of England, France, &c.
2. hemisphæricus, B. ...		E. de P. v. 8. A sulcatus, G.	1	Ditto.
3. intumescens, P. ...	..	... ...	1	Ditto.

REMAINS OF CONCHIFERA.

WITH LATERAL MUSCLES FOR CLOSING THE VALVES (PLAGYMYONA).

Subdivision 1. *Mantle partially closed behind (Clausipalla).*

Division 1.—PLAGYMYONA.

Names in this work.	Figures in this work.	Synonyms and References.	Strata in which the species occurs in Yorksh.	Other localities for the species.
PHOLADARIÆ.				
Pholas.—1. recondita, P. ...	iii. 19	... ...	6	
2. constricta, P. ...	ii. 17	... ...	3	
Gastrochæna tortuosa, S. ...	xi. 36	... ...	14	Schwerfer.
MYARIÆ.				
Mya.—1. depressa, S. ...	ii. 8	... ...	3	Havre, Dorsetshire, Market Rasen.
2. phaseolina, P. ...	ii. 13	... ...	3	
3. literata, S. ...	vii. 5	... ...	6, 7, 9, 10, 16, 14	Near Lake Bourget; Gundershofen.
4. calceiformis, P. ...	xi. 3	... ...	9, 12, 14	Cheltenham (Murch.)
5. dilata, P. ...	xi. 4	... ...	14	
6. æquata, P. ...	xi. 12	... ...	14	
other species ...	v. 23, &c.	... ...	8, 9	
Lutraria.—1. P. ...	...	... ...	3	
2. P., MS. ...	...	... ...	6	
3. gibbosa ? ? S. ...	ix. 6	... ...	12	
* Mactra veterum, P., MS. * ...	..	... ...	12	Near Bath.

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MYARIÆ.				
Amphidesma.—1. recurvum, P.	v. 25		6, 9	LonsleSaulnier, Besançon, Salêve.
2. decurtatum, P.	vii. 11		10, 12	Wilts.
3. donaciforme, P.	xii. 5		15	Altdorf, Weimar, Waldenheim.
* 4. congener	...		14	
5. securiforme, P.	vii. 10		10, 12	Wilts.
6. rotundatum, P.	xii. 6		15	Waldenheim.
CORBULEÆ.				
Corbula.—1. punctum, P.	ii. 6		3	
2. curtansata, P.	iii. 27		6, 9	
3. depressa, P.	ix. 16		12	
4. cardioides, P.	xiv. 12		17	Lower Rhine.
TELLINACEÆ.				
Sanguinolaria.—1. undulata, S.	v. 1		7, 8, 10	Brora, Switzerland, Bath.
2. vetusta, P.	xiv. 1.		16	
3. elegans, P.	xii. 9		15, 17	
Psammobia lævigata, P.	iv. 5		6, 12	
Tellina.—1. ampliata, P.	iii. 24		6	
2.	ii. 7		3	
VENERIDÆ.				
Lucina.—1. sculpta, P.	ii. 15		3	
2. crassa	...	Min. Conch. t. 557	7	Brora.
3. lirata, P.	vi. 11		9	
4. despecta, P.	ix. 8		12, 14	
Astarte.—1. aliena, P.	iii. 22		6	
2. ovata, P.	iii. 25		6	Oxon, Wilts.
3. extensa, P.	iii. 21		6	
4. lævis, P.	ii. 18, 19		3	
5. elegans, S.	xi. 41	M. C. t. 94	6, 14	Yeovil, Brora.
6. minima, P.	ix. 3		12, 14, 15	
7. carinata, P.	v. 3		7, 8, 9	
other species	...		9, 14	
* Venus, P.	...		6	
Cytherea dolabra, P.	ix. 12		6, 12	
Pullastra.—1. recondita, P.	ix. 13		12	
2. oblita, P.	xi. 15		14	
3. antiqua	xiii. 16.		16	
Corbis.—1. lævis? S.	v. 32	M. C. t. 580	6, 9	Oxon.
2. uniformis, P.	xii. 3		15	Salêve.
3. ovalis, P.	v. 29		9	
* 4. ornata, P., MS.	...		6	

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CARDIACEÆ.				
Cardium.—1. lobatum, P.	iv. 3.	...	6	
2. dissimile ? S.	v. 27	M. C. t. 553 ?	9	
3. citrinoideum, P.	vii. 7	...	10	Wilts.
4. cognatum, P.	ix. 14	...	12	Wurtemburgh.
5. semiglabrum, P.	ix. 15	...	12	
6. acutangulum, P.	xi. 6	...	12, 14	
7. truncatum, S.	xiii. 14	...	16	Lower Rhine.
8. multicostatum, P.	xiii. 21	...	16	
9. striatulum, P.	xi. 7	...	14	
10. gibberulum, P.	xi. 8	...	14	
11. incertum, P.	xi. 5	...	14	
Isocardia.—1. angulata, P.	ii. 20, 21	...	3 (12?)	
2. rhomboidalis, P.	iii. 28	...	6	
3. tumida, P.	iv. 25	...	7	
4. minima ? S.	vii. 6	M. C. t. 295	10	Wilts, near Lake Bourget.
5. nitida, P.	ix. 10	...	12	
6. concentrica, S.	xi. 40	...	12, 14	Lincolnsh., Bath, Chelt. (Mur.)
other species	...	...	6	
Cardita similis, S.	iii. 23, xi. 39	...	6, 12	Wilts, Bath.
Pholadomya.—1. decussata	ii. 9	Cardium decussatum, Mantell	3	Sussex.
2. Murchisoni, S.	vii. 9	...	10	Brora, near Lake Bourget, Suabia, Franchecomté.
3. ovalis, S.	...	M. C. t. 226	10	Felmersham.
4. producta, S.	...	M. C. t. 197	12	Peterborough.
5. nana, P.	ix. 7	...	12	
6. deltoidea, S.	...	M. C. t. 197	7	Near Lake Bourget, Peterboro'.
7. simplex, P.	iv. 31	...	7	
8. obsoleta, P.	v. 24	...	8, 9	
9. acuticostata, S.	...	M. C. t. 546	12	Gundershofen, Collyweston.
10. obliquata, P.	xii. 15	...	12, 16	Lincolnshire, Gundershofen.
NAIADÆ.?				
Unio?—1. Listeri, S.	...	M. C. t. 154	15, 17	
2. concinnus, S.	...	M. C. t. 223	15, 17	Lincolnshire, Cropredy.
3. crassiusculus, S.	...	M. C. t. 185	17	Ditto.
4. peregrinus, P.	vii. 12	...	10	Wilts.
5. abductus, P.	xi. 42	...	14, 16	Cheltenham (Murch.)
MYTILACEÆ.				
Modiola.—1. scalprum, S.	xiv. 2	...	14	Isle of Pabba, Wurtemburgh.
2. plicata, S.	...	M. C. t. 248	16	Near Lake Bourget, Bath.
3. bipartita, S.	iv. 30	...	7	

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MYTILACEÆ.				
4. cuneata, S. ...	v. 28	... ...	8, 9, 10, 12	Wilts.
5. Hillana, S. ...	...	M. C. t. 212 ...	15	Pickeridge Hill.
6. ungulata, P. ...	...	Y. and B. Pl. 7, fig. 10 ..	6, 12, 14	
7. pulchra, P. ...	v. 26	... ...	9	
8. aspera ? S. ...	xi. 9	M. C. t. 212 ...	14	Felmersham.
9. inclusa, P. ...	iii. 20	... ...	6	Wilts, Oxon.
Mytilus.—1. cuneatus, P. ...	xi. 21	... ...	14	
? 2. amplus, S. ...	...	M. C. t. 7 ...	6	Verdun, near Bath.
Hippopodium ponderosum, S. ...	...	M. C. t. 250 ...	(6 ?) 16	

Subdivision 2. *The mantle entirely open* (*Patulipalla*, LAT.)

ARCADÆ.				
Cucullæa.—1. oblonga, S. ...	iii. 34	M. C. t. 206 ...	6	Dundry.
2. contracta, P. ...	iii. 30	... ...	6	
3. triangularis, P. ...	iii. 31	... ...	6	
4. pectinata, P. ...	iii. 32	... ...	6	
5. elongata ? S. ...	iii. 33, xi. 43	M. C. t. 447 ...	6, 12, 14	Near Bath.
6. concinna, P. ...	v. 9, vi. 31	... ...	8, 9	St. Claude (Jura.)
7. imperialis, Bean ...	ix. 19	... ...	12	
8. cylindrica, P. ...	ix. 20	... ...	12	
9. cancellata, P. ...	ix. 24, xi. 44	... ...	12, 14	
10. reticulata, Bean ...	xi. 18	... ...	14	
other species ...	...	... ...	3, 15	
Arca.—1. quadrisulcata, S. ...	...	M. C. t. 473 ...	6	
2. æmula, P. ...	iii. 29	... ...	6	
Nucula.—1. ovata, S. ...	ii. 10	... ...	3	Sussex.
2. subrecurva, P. ...	ii. 11	... ...	3	
3. ? elliptica, P. ...	v. 6	... ...	8	
4. nuda, P. ...	v. 5	... ...	8	
5. variabilis, S. ...	ix. 11	... ...	12, 14	Ancliff, near Bath.
6. lachryma, S. ...	xi. 14	... ...	12, 14	Ditto.
7. axiniformis, P. ...	xi. 13	... ...	14	
8. ovum, S. ...	xii. 4	... ...	15	Near Chipping Warden (P.)
9. complanata, P. ...	xii. 8	... ...	15	
other species ...	ii. 12, v. 4	... ...	8	
TRIGONIACEÆ.				
Trigonia.—1. costata, S. ...	...	M. C. t. 85 ...	6, 9, 10, 12	{ Oolites of South of England
2. clavellata, S. ...	...	M. C. t. 87 ...	6, 9, 10, 12	{ and France.

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TRIGONIACEÆ.				
Trigonia.—3. conjungens, P. ...	...	... ...	12	
4. angulata, S. ...	...	M. C. t. 508 ...	14	
5. striata, S. ...	xi. 38	M. C. t. 237 ...	14	Inferior oolite, near Bath.
6. literata, P. ...	xiv. 11	... ...	17	Resembles trigonia navis of the German lias.

WITH A LARGE NEARLY CENTRAL MUSCLE FOR CLOSING THE VALVES.

Division 2.—MESOMYONA.

PINNACEÆ.				
Pinna.—1. gracilis, P. ...	ii. 22	... ...	3	
2. mitis, P. ...	v. 7	... ...	8, 9	
3. lanceolata, S. ...	iv. 33	M. C. t. 281 ...	6, 7	
4. cuneata, Bean ...	ix. 17	... ...	10, 12	
5. folium, Y. and B. ...	xiv. 17	.. ...	17	
Trigonellites.—1. antiquatus, P. ...	iii. 26	... ...	6	
2. politus, P. ...	v. 8	... ...	8	
OXYGONÆ.				
Perna quadrata, S. ...	ix. 21, 22	... ...	6, 12	
Crenatula ventricosa, S. ...	...	M. C. t. 443 ...	16	
Inoceramus.—1. Cuvieri, S. ...	...	M. C. t. 441 ...	1	
2. Brongniarti, S. ...	...	M. C. t. 441 ...	1	
3. cranium, P. ...	...	(Yorkshire Museum) ...	1	
4. mytilloides, S. ...	...	M. C. t. 442 ...	1	
5. dubius, S. ...	β. xii. 14.	α. M. C. t. 584 ...	15	
Gervillia.—1. aviculoides, S. ...	...	M. C. t. 511, and t. 66 ...	6, 7	Oxon, Hants.?
2. acuta, S. ...	ix. 36	... ...	12	Stonesfield, Collyweston.
3. lata, P. ...	xi. 16	... ...	14	
Avicula.—1. elegantissima, (Bean) ...	iv. 2	... ...	6	
2. tonsipluma, P. ...	...	Y. & B., t. vii. 15 ...	6	
3. ovalis, P. ...	iii. 36.	Plagiostoma concentricum, S.?	6, 7	
4. expansa, P. ...	iii. 35	... ...	6, 8, 9	
5. Braamburiensis, S. ...	vi. 6	... ...	9, 12	
6. inæquivalvis, S. ...	xiv. 4	... ...	14, 16	Pyrton Passage, Gundershofen.
7. (like echinata) P. ...	...	... ...	15	Westbury.
8. cygnipes, P. ...	xiv. 3	Pecten cygnipes, Y. and B.		

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PECTENIDÆ.				
Plagiostoma.—1. giganteum, S. ...	...	M. C. t. 77 ...	14, 16	
2. læviusculum, S. ...	...	β M. C. t. 382 ...	6	Oxon.
3. cardiiforme, S. ...	...	M. C. t. 113 ...	12, 14	
4. rigidum, S. ...	...	M. C. t. 114 ...	6	Oxon.
5. rigidulum, P. ...	vii. 13	... ...	10	
6. rusticum, S. ...	...	M. C. t. 381 ...	6	Oxon.
7. Hermanni, Voltz. ...	...	... ...	16, 17	Lias of Bath, France, Germany.
8. pectenoideum, S. ...	xii. 13	M. C. t. 114, fig. 4 ...	15	Bath, &c.
9. duplicatum, S. ...	...	M. C. t. β vi. 2 ...	6, 8, 9	
10. interstinctum, P. ...	vii. 14	... ...	10, 12	
other species ...	v. 10	... ...	8	
Dianchora striata, S. ...	...	M. C. t. 80 ...	1	
Lima.—1. rudis, S. ...	...	M. C. t. 214 ...	6, 7, 12	Wilts, Brora.
2. proboscidea ? S. ...	...	M. C. t. 264 ...	14	
Plicatula spinosa, S. ...	xiv. 15	... ...	17	Gundershofen.
Pecten.—1. æquivalvis, S. ...	...	M. C. t. 136 ...	16	
2. sublævis, S. ...	xiv. 5	... ...	16	
3. inæquicostatus, P. ...	iv. 10	... ...	6	Oxon, Verdun.
4. vagans, S. ...	...	M. C. t. 543 ...	6, 7	Oxon.
5. fibrosus, S. ...	vi. 3	M. C. t. 136 (doubtful if distinct from the preceding)	9, 10	Wilts.
6. vimineus, S. ...	..	M. C. t. 543 ...	6	Oxon, Berks, Wilts.
7. virguliferus, P. ...	xi. 20	... ...	14	
8. abjectus, P. ...	ix. 37	... ...	6, 12, 14	Oxon.
9. lens, P. ...	...	P. lens et P. arcuatus, Sow. M. C. t. 205 ...	6,9,&c. 12, 14, 16	
10. demissus, P. ...	vi. 5	... ...	6,9,10,&c. 12	
11. cancellatus (Bean) ...	...	... ...	6	
other species ...	v. 11	... ...	3, 8, &c.	
OSTRACIDÆ.				
Ostrea.—1. Marshii, S. ...	...	M. C. t. 48 ...	8, 10, 12	Bedfordshire, Oxon.
2. gregarea, S. ...	...	M. C. t. 111 ...	6, 7, 12	Wilts, Berks.
3. solitaria, S. ...	..	M. C. t. 468 ...	6	Oxon, &c.
4. duriuscula, (Bean) ...	iv. 1	... ...	6	
5. inæqualis, P. ...	v. 13	... ...	8	
6. undosa, Bean. ...	vi. 4	... ...	9	
7. deltoidea, S. ...	...	M. C. t. 148 ...	4	Wilts, Berks, Dorset, Havre.
8. archetypa, P. ...	vi. 9	... ...	9	
9. sulcifera, P. ...	ix. 35	... ...	12	
other species ...	v. 12	... ...	8, 10, 12	

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OSTRACIDÆ.						
Gryphæa.—1. incurva, S.	...	...	M. C. t. 112	...	17	Thionville, nr. Donaueschingen, &c.
2. maccullochii, S.	...	...	M. C. t. 547	...	17	Meurthe.
3. dilatata, S.	...	β vi. 1	...	...	9	
4. bullata, S.	...	iv. 36	...	...	6, 7	Wilts, Brora.
5. inhærens, P.	...	...	...	...	6, 7	
6. gigantea ? S.	...	...	M. C. t. 391	...	12	
7. depressa, P.	...	xiv. 7	..	...	16	
8. sinuata, S.	...	ii. 23	...	...	3	Kent, Isle of Wight, &c.
9. mima, P.	...	iv. 6	...	...	6, 7	
10. chamæformis, P.	...	...	Smith, fig. 5	...	7	Brora, &c.
other species.	...	ix. 26	...	...	12, 14	

ANIMALS WITH CILIATED TENTACULA AT THE MOUTH. SHELLS EQUILATERAL.

Division 3.—BRACHIOPODA.

INÆQUIVALVIÆ.						
Terebratula.—1. intermedia, S.	...	...	M. C. t. 15	...	6, 7, 12	
2. trilineata, Y. and B.	...	...	Y. and B. t. 8, fig. 14	...	14, 16	
3. subundata, S.	...	ii. 25, 26	M. C. t. 15	...	1, 3	
4. semiglobosa, S.	...	...	M. C. t. 15	...	1, 3	
5. lineolata, P.	...	ii. 27.	...	...	3	
6. ornithocephala, S.	...	vi. 7	M. C. t. 101	...	7, 9	Kelloways.
7. ovoides, S.	...	...	M. C. t 100	...	10	
8. digona, S.	...	...	M. C. t. 96	...	10	Wilts, Dorsetshire.
9. punctata, S.	...	...	M. C. t. 15	...	16	
10. ovata ? S.	...	...	M. C. t. 15	...	6	
11. globata, S.	...	...	M. C. t. 436	...	6, 12	Near Lake Bourget.
12. bucculenta et emarginata, S.		...	M. C. t. 435 and 438	...	6	
13. carnea, S.	...	...	M. C. t. 15	...	1	Norfolk, &c.
14. acuta, S.	...	xiii. 25	...	...	16	
15. bidens, P.	...	xiii. 24	...	...	16	Lower Rhine.
16. tridentata, P.	...	xiii. 22	...	...	16	Ditto.
17. tetraëdra, S.	...	...	M. C. t. 83	...	15, 16	
18. subplicata, Mant.	...	...	Geol. Suss. 26, 5	...	1	
19. socialis, P.	...	vi. 8	...	...	7, 9	
20. obsoleta, S.	...	...	M. C. t. 83	...	6	
21. spinosa, Smith	...	ix. 18	...	...	12	Lincolnsh., near Bath, Seysell, near Lake Bourget, Gundersh.

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INÆQUIVALVIÆ.				
Terebratula.—22. inconstans, S.	ii. 24	...	3	Wilts, Dorsetshire.
23. striatula, S.	ii. 28	...	3	
24. pentagonalis, P.	i. 17	...	1	
25. resupinata, S.	xiii. 23	...	16	
Spirifera Walcottii, S.		M. C. t. 377	17	Doubs.
Orbicula.—1. reflexa, S.		M. C. t. 506	15	
2. radiata, P.	iv. 12	...	6	
3. latissima, S.		M. C. t. 139	8	Lincolnshire.
others		...	3, 8, 14	
EQUIVALVIÆ.				
Lingula Beanii, P.	xi. 24	...	14	Nr. Luxemburg, Gundershofen.

REMAINS OF GASTEROPODA.

Auricula.—1. obsoleta, P.	ii. 40	...	3	
2. Sedgvici, P.	xi. 33	...	14	
Bulla elongata, P.	ix. 7	...	6	
Actæon.—1. glaber, Bean	ix. 31	...	12, 14	
2. humeralis, P.	xi. 34	...	14	
3. retusus, P.	iv. 27	...	7	
other species	...	...	10, 15	
Melania.—1. striata, S.	...	M. C. t. 47	6, 12	
2. Heddingtonensis, S.	...	M. C. t. 39	6, 10, 12, 14	Oxon, Brora.
3. lineata, S.	...	M. C. t. 218	14	
4. vittata, P.	vii. 15	...	6, 10	
Phasianella cincta, P.	ix. 29	...	12	
Turritella.—1. muricata, S.	iv. 8	...	6, 7, 9, 14	
2. cingenda, S.	xi. 28, 29	...	6, 12, 14	Lincolnshire, Bath.
3. quadrivittata, P.	xi. 23	Nerinea Auct.	14	
other species	...	...	3, 15	
Turbo—1. muricatus, S.	iv. 14	M. C. t. 240	6, 12, 14	Wilts, Berks, &c.
2. funiculatus, P.	iv. 11	...	14	
3. unicarinatus, Bean	...	...	6	

Names in this work.	*Figures in this work.*	*Synonyms and References.*	*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
Turbo.—4. pulcherrimus, Bean ...	ii. 35	... ...	3	
5. sulcostomus, P. ...	vi. 10	... ...	9	
6. lævigatus, P. ...	xi. 31	Nerita lævigata S. ...	14	
7. undulatus, P. ...	xiii. 18	... ...	16	
Delphinula, species not easy to determine ...	ix.32,&c.,ii.32 &c.	... ..	3, 6, 12	
Cirrus.—1. depressus, P. ...	vi. 12	... ...	9	
2. cingulatus, P. ...	iv. 28	... ...	7	
Solarium.—1. tabulatum, P. ...	ii. 36	... ...	3	
2. calix, Bean ...	xi. 30	... ...	14	
Trochus.—1. granulatus, S. ...	...	M. C. t. 220 ...	6, 10, 14	Oxon, Dundry.
2. reticulatus? S. ...	...	Smith, fig. 3 ...	3	North Wilts, Garsington, &c.
3. pyramidatus, (Bean) ...	xi. 22	... ...	14	Little Sodbury, &c.
4. bisertus, P. ...	xi. 27	... ...	14	
5. moniliferus, P. ...	ix. 33	... ...	12	
6. bicarinatus, S. ...	...	M. C. t. 221 ...	6	
7. tornatus, P. ...	iv. 16	... ...	6	
8. guttatus, P. ...	vi. 14	... ...	9	
9. anglicus, S. ...	...	M. C. t. 142 ...	17	Bath, Lincolnshire.
Nerita costata, S. ...	xi. 32	... ...	14	Ancliff, near Bath.
Natica.—1. tumidula, P. ...	xi. 25	Nerita minuta, S. ...	14	Dundry.
2. arguta, P. ...	...	Smith, fig. 2. ..	6	
3. nodulata, P. ...	...	Y. and B. t. xi. fig. 3 ...	6	
4. cincta, P. ...	iv. 9.	... ...	6	
5. adducta, P. ...	xi. 35, ix. 30	... ...	12, 14	
6. undetermined ...	...	... ...	17	
Terebra.—1. melanioides, P. ...	iv. 13	... ...	6	
2. granulata, P. ...	vii. 16	... ...	6, 10	
3. vetusta, P. ...	ix. 27	... ...	12, 14	
* 4. mitriformis, P., MS. ...	...	... ...	6	
Murex Haccanensis, P. ...	iv. 18	... ...	6	
Rostellaria.—1. Parkinsoni, S. ...	ii. 33, 34	M. C. t. 558 ...	3	Folkstone, Isle of Wight, &c.
2. composita, S. ...	vi. 13	M. C. t. 558? ...	12, 14	Brora, Weymouth.
3. bispinosa, P. ...	v. 14	... ...	7, 9	
4. trifida, P. (Bean) ...	...	... ...	8	

REMAINS OF CEPHALOPODA.

Names in this work.	Figures in this work.	Synonyms and References.	Strata in which the species occurs in Yorksh.	Other localities for the species.
BELEMNITES.				
* (S. G. *Actinocamax*, Miller)				
1. gracilis, P. ...	v. 15	(Large specimen) ...	8	
2. jaculum, P. ...	iii. 1	B. fusiformis, Ph. Edit. 1, allied to B. lanceolatus, S.	3	
**				
3. mucronatus, B. ...	...	E.deP.iii.1.(B.electrinus,Miller)	1	South of England, France, &c.
4. granulatus, Bl. S. ...	...	M. C. t. 60 ...	1	Scania, &c. Westphalia.
5. Listeri, P. ...	i. 18	... ...	2	
6. minimus, S. ...	...	M. C. t. 589 ...	3	Folkstone, Wilts., Bedfs.
***				
7. abbreviatus, Miller ...	...	G. T. 2 Ser. ii. 7, 9 ...	6	Gloucestershire.
8. compressus, Voltz & P.	xii. 21	Voltz, v. ...	12	
9. paxillosus, Voltz ...	...	Voltz, vi. 2 ...	15	Gloucestershire.
10. trifidus, Voltz ...	...	Voltz, vii. 3 ...	15	
11. subaduncatus, Voltz ...	...	Voltz, iii. 2 ...	15	
12. tubularis, Y. and B. ...	xii. 20	... ...	15	
13. Aalensis, Voltz ...	...	(? B. ellipticus, Miller) ...	12	Aalen, &c. Wurtemburg.
14. quinquesulcatus, Bl. ...	ix. 38	(B. compressus) (B.abbreviatus,P.Edit.i.S)	12	
* 15. tornatilis, P. ...	...	Smith, clunch clay, fig. 1 ?	9	Wiltshire.
* 16. lateralis, P. ...	...	Y. and B. t. 15, fig. 2 ...	3	
* 17. Blainvillii, Voltz ...	...	Voltz, i. 9 ...	6	Stonesfield ?
* 18. anomalus, P. ...	...	... ...	9	
NAUTILUS.				
1. lineatus, S. ...	...	M. C. t. 41 ...	14	Near Bath.
2. *astacoides*, Y. and B. ...	xii. 16	Y. and B. xiii. 2 ...	15	
3. hexagonus, S. ...	...	M. C. t. 529 ...	9	Oxford.
4. annularis, P. ...	xii. 18	... ...	15	
other species ...	...	... ...	3, 12, &c.	
AMMONITES. * No dorsal keel nor furrow. † *Back plano dentate at least when young.*				
1. Calloviensis, S. ...	...	Smith. Kell. Rock, fig. 3, including a. gulielmi, S.	9	Kelloways, Thurnau.

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AMMONITES.				
2. Duncani, S. ...	vi. 16	... ...	9	St. Neots.
3. gemmatus, P. ...	vi. 17	a. spinosus ? S. ...	9	Weymouth.
4. Gowerianus, S. ...	vi. 21	M. C. t. 549 ...	9	Brora.
5. Kœnigi, P. ...	vi. 24	... ...	9	Kelloways, Cromarty, Switzerl.
† *Back dentate, plano sulcate.*				
6. splendens, S. ...	...	M. C. t. 103, (found at Speeton by Mr. Allis, 1835.)	3	Folkstone, Wilts. &c.
7. planus, S. ...	ii. 42	... ...	3	Sussex, Thurnau.
Macrocephali et Coronarii, V. B.				
8. sublævis, S. ...	vi. 22	M. C. t. 54 ...	6, 9	Kelloways.
9. marginatus, P. ...	ii. 41	... ...	3	Thurnau.
10. nucleus, P. ...	ii. 43	... ...	3	
11. terebratus, P. ...	...	... ...	10	
12. Herveyi, S. ...	...	M. C. t. 195 ...	10	Lincolnshire.
13. Cheltensis, Murch. }	...	{ Geol. of Chelt. } Are these	15	Towcester, Cheltenham, Metz.
14. Henleyi, S. }		{ M. C. t. 172 } really distinct.	15	Lyme regis.
15. heterogeneus, Y. and B.	xii. 19	... ..	15	
16. heterophyllus, S. ...	...	M. C. t. 266 ...	15	Sardon, Jura.
17. Sutherlandiæ, S. ...	...	M. C. t. 563 ...	15	Brora.
18. rotula, S. ...	ii. 45	... ...	3	Au Nord de Castellan.
19. trisulcosus, P. ...	...	... ...	3	
20. venustus, P. ...	ii. 48	... ...	3	
21. concinnus, P. ...	ii. 47	... ...	3	Thurnau, Weymouth ?
22. subcarinatus, Y. and B.	xiii. 3.	... ...	15	Thurnau.
(*Dorsati, Planulati, Armati, Von B.*)				
23. plicomphalus, S. ? ...	...	M. C. t. 359, t. 404 ...	4	Bolingbroke, Lincolnshire.
24. Blagdeni, S. ..	...	M. C. t. 201 ...	12	Sherborn, Metz, Basel, &c.
25. subarmatus, S. ...	...	M. C. t. 407 ...	15	
26. armatus, S. ...	...	M. C. t. 95 ...	15	Charmouth.
27. fibulatus, S. ...	...	M. C. t. 407 ...	15	
28. crassus, Y. and B. ...	xii. 15	A Deslongchampii Def. ...	15	{ Himalaya mountains, Heimberg, N. E. of Salins.
29. communis, S. ..	..	M. C. t. 107 ...	15	Meyringen, Altdorf.
30. annulatus, S. ...	...	M. C. t. 222 ...	15	Cropredy.
31. angulatus, S. ...	..	M. C. t. 107 ...	15	
32. plicatilis, S. ...	...	M. C. t. 166 ...	6	Solenhofen.
33. triplicatus, S. ...	...	M. C. t. 292 ...	6	
34. Vernoni, Bean ...	v. 19	... ...	8	Brora.
35. bifrons, P. ...	vi. 18	... ...	9	
36. fissicostatus, P. ...	ii. 49	... ...	3	

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AMMONITES.				
37. athleta, P. ...	vi. 19	... ...	9	
38. perarmatus, P. ...	...	M. C. t. 352 ...	6, 9	
39. curvinodus, P. ...	ii. 50	... ...	3	
40. hystrix, P. ...	ii. 44	... ...	3	
(Capricorni Von. B.)				
41. Williamsoni, P. ...	iv. 19.	... ...	6	
42. maculatus, Y. and B. ...	viii. 11	... ..	15, 16	
43. planicostatus, S. ...	...	M. C. t. 73 ...	...	Near Yeovil.
44. gagateus, Y. and B. ..	...	Y. and B. xii. 7 (2d Edit.)		
45. *hemisculptus, P., MS.*	...	Mr. Ripley ...	16	
46. brevispina, S. ..	...	M. C. t. 556 ...	17	Pabba.
47. Jamesoni, S. ...	...	M. C. t. 555 ...	17	Mull.
48. balteatus, P. ...	xii. 17	... ...	15	
49. erugatus, Bean ...	xiii. 13	... ...		
50. * lateralis, P., MS. * ...	...	Mr. Lee		
51. arcigerens, P. ...	xiii. 9	... ...	...	Wurtemburg.
52. fimbriatus, S. ...	...	M.C.t.164. A.cornucopiæ,Y.&B.		
53. nitescens, Y. and B. ...		... ...		
54. anguliferus, P. ...	xiii. 19	... ...	16	Heimberg, Göttingen, Avesnes, Amberg.
(Amalthei, Von B.)				
55. crenularis, P. ...	xii. 22	... ...	15	
56. flexicostatus, P. ...	vi. 20	... ...	9	
57. Lamberti, S. ...	...	M. C. t. 242 ...	3, 6	Weymouth, Portland.
58. *retroflexus, P., MS. *...	...	Mr. Sykes ...	7	
* * a crenated dorsal keel, *(amalthei, V. B.)*				
59. lenticularis, P. ...	vi. 25	... ...	6, 9, (16)	
60. funiferus, P. ...	vi. 23	... ...	9	
61. Clevelandicus, Y. and B.	xiv. 6	a. Stokesi, S.? t. 191 a. serratus, S. t. 24	16	Bridport, Wurtemburg.
62. vertebralis, S. ...	iv. 34	M. C. t. 165 ...	6, 7, 8	Brora, Oxon, &c., Soissons, Requensburg.
63. Hawskerensis, Y. and B.	xiii. 8	... ...	16	BanzontheMayne, Wurtemburg.
64. geometricus, P. ...	xiv. 9	... ...	17	
65. oculatus, P. ...	v. 16	... ...	8	
* * * a simple dorsal keel, *(falciferi, V. B.)*				
66. Lythensis, Y. and B. ...	xiii. 6	... ...	15	Gundershofen, Phoren.
67. Boulbiensis, Y. and B....	...	... ...	15	
68. impendens, Y. and B. ...	...	... ...	15	
69. Mulgravius, Y. and B....	...	Y. and B. t. 13, fig. 8 ...	15	

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AMMONITES.				
70. exaratus, Y. and B.	xiii. 7	...	15	Gundershofen.
71. elegans, S.	xiii. 12	M. C. t. 94	15	Lauensheim.
72. ovatus, Y. and B.	xiii. 10	...	15	
73. striatulus, S,	...	M. C. t.	15	Wasseralfingen, Gundershofen.
74. sigmifer, P.	xiii. 4	...	15	
75. vittatus, Y. and B.	xiii. 1	...	15	
76. solaris, P.	iv. 29	...	6	
77. Turneri? S.	xiv. 14	...	17	Watchet.
78. obliquatus, Y. and B.	...	...	15	
other species.	...	...	9, 14, &c.	
* * * * a dorsal keel between two furrows, (*Arietes*, V. B.)				
79. Walcottii, S.	...	M. C. t. 106	17, 15	Weimar, Metz, Boll, &c.
80. Bucklandi, S.	xiv. 13	M. C. t. 130	17	Nr.Chalons,nr.Donaueschingen
81. obtusus, S.	...	M. C. t. 167. Redcarensis,? Y. and B.	17, 16	
82. Conybeari,	...	M. C. t. 131	16	Near Donaueschingen.
Hamites.—1. maximus, S.	i. 20, 21	M. C. t. 62	...	The species so named by Mr. Sowerby, and Mantell, occur in Kent, Sussex, Wilts, &c. but in these districts they rarely appear in a spiral form. In Yorkshire they are not often found otherwise.
2. intermedius, S.	i. 22	M. C. t. 62	...	
3. raricostatus, P.	i. 23	...	...	
4. rotundus, S.	i. 24	M. C. t. 61	...	
5. attenuatus, S.	i. 25	M. C. t. 61	...	
6. alternatus, S.	i. 26, 27	...	...	
7. Beanii, P.	i. 28	...	...	
8. plicatilis, S.	i. 29	M. C. t. 236	...	
9. Phillipsii, Bean	i. 30	...	...	
(Conularia quadrisulcata)	admitted by mistake		...	It belongs to mountain and trans. lime, &c.

REMAINS OF ANNULOSA.

Serpula.—1. deplexa, Bean	xi. 26	...	14	
2. capitata, S.	xiv. 16	...	17	
3. squamosa, Bean	iv. 15	See serpula sulcata, M. C. t.608	6	
4. lacerata, P.	iv. 35	...	7, 12	
5. intestinalis, P.	v. 21	...	8, 10	
6. a quadrate species, P.	...	S. tetragona, Sow. t. 599	10, 12	
other species	...	i. 19, ii. 30	2, 3	

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Vermicularia.—1. Sowerbii, Mant. ...	ii. 29	... ...	3	
2. nodus, P. ...	ix. 34	... ...	10, 12	
3. compressa, Y. and B. ...	iv. 17	Vermetus tumidus, M. C. t. 596	6	
	ii. 37	Vermetus concinnus, M. C. t. 596	14	
Dentalium.—1. giganteum, P. ...	xiv. 8	... ...	16	
others ...	ii. 31	... ...	3	

REMAINS OF CRUSTACEA.

Names in this work.	*Figures in this work.*	*Synonyms and References.*	*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
Astacus.—1. rostratus, P. ...	iv. 20	... ...	6, 7, 8, 9, 10, 12	
2. * scabrosus (P., MS.) ...	...	Museum of the Y. P. Society	6, 7, 9	
3. ornatus, P. ...	iii. 2	... ...	3	
4. mucronatus, (P., MS.) ...	iii. 3	Williamson's & Bean's Cabinets	8	
5. * Stricklandi (Bean, MS.) ..	...	Bean's Cabinet ...	8	
New genus? * leptomanus (P., MS.) ...	...	Cabinets of Bean, Dunn, and the Author	8	
* another species (P., MS.)	...	... ...	clay over 10	
* Palinurus uncinatus (P., MS.) ...	...	Williamson's & Bean's Cabinets	3	
* Cancer (a claw) ...	...	Bean's Cabinet ...	10	

REMAINS OF FISHES.

Names in this work.	*Figures in this work.*	*Synonyms and References.*	*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
Teeth of Squali, &c. &c. ...	ii. 51, 52, 53	Speeton clay, Coralline oolite, &c.		
Jaw of Gyrodus minor, Agassiz ...	ii. 55	Speeton clay.		
Ichthyodorulites ...	...	Lias.		
Several species of fishes in the Lias of Yorkshire ...	...	One of them of gigantic dimensions, will be described in M. Agassiz's splendid Work on Fossil Ichthyology.		

REMAINS OF REPTILES.

Names in this work.	*Figures in this work.*	*Synonyms and References.*	*Strata in which the species occurs in Yorksh.*	*Other localities for the species.*
Crocodilus ...	...	Coralline oolite.		
Ichthyosaurus.—1. communis	xii. 1	Upper Lias of Yorkshire.		
2. platyodon				
3. ——— ...	ii. 2			
undetermined ...	...	Speeton clay, Coralline oolite, Lias, &c.		
Plesiosaurus. Undetermined ...	...	Cave oolite and Lias.		

CHAPTER V.

On the Basaltic Dyke.—On the economical Uses of the Mineral Products in the Eastern part of Yorkshire.

ONE of the most remarkable features on a geological map of England is the line of the great trap dyke, from beyond Cockfield fell in Durham to the Sneaton moors in Yorkshire, a distance of sixty miles. That this subterranean wall of basalt is really connected through the whole of this length, few will be inclined to dispute who have studied the character of the rock, and observed its bearings at Cockfield fell, Bolam, Langbargh, and Silhoue cross; but it is not traceable between all these points on the surface of the ground. It is a common opinion, that this dyke is united, toward the west, with the "great whin sill," or basaltic formation of Upper Teesdale, from the eastern end of which another long dyke appears to arise. On the east it does not reach the sea side, but terminates obscurely, after crossing near its source the easternmost branch of Littlebeck. Its general direction is E. S. E. and W. N. W.; but in several places considerable deviations in this respect are observable. The breadth is commonly about sixty feet, as at Cockfield fell, Langbargh quarry, and Egton; but it diminishes to less than thirty feet at the eastern extremity. At Bolam in Durham, it expands into a large pyriform mass, having the appearance of an interposed bed, resting on black shale. The sides of the dyke are seldom perpendicular, but generally slope downwards toward the north. At Langbargh quarry this slope is about 1 in 8. The strata through which the dyke passes are generally dislocated, so that a given layer is found considerably higher on the south side than on the north.

As might be expected, this hard rock has been less wasted by watery currents and the changes of the atmosphere, than the softer strata which

bound it, and, therefore, in some places it appears above them in a long crust or ridge. On Clifton rigg its blocks, lying bare on the surface, have been compared to prostrate pilasters half buried in ruins; near Egton bridge it stands up in a lofty wall, over the waters of the Esk; and beyond Silhoue cross, it ranges along the moors like an ancient military road; but in a large portion of its course, especially in the wide vale of Tees, it is concealed by diluvial accumulations.

The composition of the basalt presents few peculiarities. Olivine, calcareous spar, mesotype, and quartz are the principal extraneous minerals. Hollow geodes occur in it, of which the walls are amethystine quartz, presenting crystalline facets to the cavity which contains a crystal of carbonate of lime. The joints, which are often lined by a sooty substance, are in most quarries irregular, and lie in all directions; but sometimes a tendency may be noticed to that horizontal prismatic structure, which prevails in narrower dykes of the same substance in the island of Arran. At Bolam, in Durham, where the mass extends itself more horizontally, the pseudo-prisms approach to a vertical position. Thin, flexuous, irregular, nearly horizontal layers of basalt appear in Langbargh quarry, and decomposing balls, with ochry outsides, are common.

The following strata are divided by this remarkable dyke; viz. mountain limestone near Middleton; sandstone, shale, and coal, in Durham; magnesian limestone, new red sandstone, and red marl, in Durham and the north of Yorkshire; lias shale, &c. and the lower sandstones of the oolitic series, in the north-eastern moorlands. These strata, where they come in contact with the basalt, are more or less altered in appearance and composition, and the change seems generally due to the action of heat. At Cockfield fell, the coal near the dyke is converted to a black substance like concreted soot, at a small distance changed to a cinder without bitumen or sulphur, and beyond, gradually regains its usual properties. "In the stratum above the cinder a great deal of sulphur is sometimes found, in angular forms, of a bright yellow colour, and very beautiful."* "At Berwick on the Tees, the white sandstone is usually a

* Mr. D. Tuke, in a communication to the Yorkshire Philosophical Society.

good workable freestone, but where the dyke passes through it, is so much indurated as to be unfit for masonry, and is only employed for embankments and similar purposes. In Kildale, the action of heat upon the contiguous shale seems to be plainly discernible; part of it has been quite bleached, perhaps converted into sulphate of alumine; in other parts it has the aspect of scoria, and the iron appears as a loose yellow ochre."* At Egton Bridge the blue lias shale is changed by the dyke to a pale greenish yellow, and made to resemble jasper in hardness. A white indurated earth in some places separates the dyke from the neighbouring strata; and occasionally the external portions of basalt are changed to a friable mass, the iron oxidated, and the felspar decomposed to porcelain clay.

To specify the most valuable mineral productions, to determine their relative importance and aptitude for economical uses, and to fix the principles which should guide adventurers in quest of them, is the pleasing duty of a practical geologist. No part of England enjoys greater advantages from the variety and value of its subterranean treasures than Yorkshire. Its rich mines of iron, lead, and zinc, its vast collieries, and innumerable quarries of building stone, flagstone, slate, and limestone, are productive of increasing wealth and convenience at home, and of considerable benefit to the empire at large. The eastern part of the county, though less distinguished in this respect than the western, contains many useful minerals, and besides supporting a very important inland commerce, is capable of furnishing large supplies for exportation.

COAL occurs extensively in the north-eastern part of Yorkshire, in the sandstone series between the gray limestone and the dogger, but always in thin seams, and generally of inferior quality. The immense advantages which would arise to this district from the working of thick seams of good coal, sufficiently account for the many unsuccessful

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* Rev. L. V. Harcourt, in a valuable communication on the Geology of Cleveland.

attempts to discover them. The opinions of *working colliers* on this point have too often been preferred to the legitimate deductions of science, and even yet persons will perhaps be found willing to credit the delusive tale of finding good coal by *going deeper*. But the warning must be given, though it be disregarded; and from all the natural exhibitions on the coast, as well as from the result of every experiment inland, I am compelled to state, that any hope of discovering seams of coal more than eighteen inches or two feet in thickness, in any part of the strata *above* the upper lias or alum shale, is entirely unsupported by reason and experience. That the coal measures of Durham and western Yorkshire exist (covered by magnesian limestone and red sandstone) *beneath* the lias, is probable, but the practicability of reaching them by pits, even in Cleveland, or near York, is very questionable, and the expense of the experiment may be ruinous.

Of several thin and variable seams of coal which appear among the sandstone rocks above the lias, only the lower one immediately above the dogger, and the upper one not far beneath the gray limestone, have been found worth the expense of working. The upper seam is the most regular, and has been worked at Cloughton Wyke, Maybecks, Goadland, Glaizedale, Danby, Shunnor Hoe, Blakehoe, Rudland, Coxwold, Newborough Park, Colton, &c.: that this and the lower seam may be opened in new places, is highly probable, and such attempts may be productive of much local advantage, but they should be guided by *geological induction*, and not abandoned to *ignorance and empiricism*.

The manufacture of ALUM from the upper lias shale, has furnished extensive employment and considerable emolument, but there appears little encouragement to establish works in new situations. The principal material in the process does not retain its essential characters much further south than the present establishments; and the difficulty of transporting materials to a distance will probably confine the trade to the vicinity of the Peak, Lyth, Kettleness, Boulby, Rockcliff, and Guisborough.

Ironstone abounds on this coast, and has been formerly shipped in large quantities to Newcastle. Inland, ironworks, established by the monks, were formerly carried on near Rievaulx abbey, and further up in Bilsdale, and in the valley of Hackness. The principal repositories of this mineral are above the gray limestone, and below the upper lias or alum shale. It is at present of no value except as ballast. No other metallic ores are in sufficient plenty to deserve mention.—The calcareous nodules which abound in the lias, have been used with success in fabricating "Roman cement."

Building stone has been obtained from every calcareous and arenaceous rock in this district. The use of the chalk and marlstone is very limited, but the other strata have been extensively employed in old churches and mansions, and even transported to considerable distances. The most valuable appear to be the calcareous grit employed in the edifices of Castle Howard and Duncombe Park; the Kelloways sandstone, of which the hall and old church at Hackness, and the Museums at York and Scarborough are constructed; and the freestone of the lower sandstone series, which has been shipped in great quantity from Whitby, being much esteemed for piers, and bridges, and other works, requiring large blocks of stone. Guisborough priory and other ancient buildings in the northern part of the district, prove the durability of this stone: and Whitby abbey, though desolate and neglected, and exposed on a bare sea cliff, has not lost its beautiful tracery. The calcareous grit and the Kelloways rock at Hackness, seem equally durable, and are, in general, of a finer grain and more uniform colour.

Flagstone, of excellent quality, is dug on the estate of Hackness, and, being conveniently situated near the sea, may probably be sent on favourable terms to the London market. It also occurs in Newtondale.

Lime is obtained from the chalk, coralline oolite, and gray limestone, or Cave oolite; and some unsuccessful trials have been made upon the calcareous dogger. The hard chalk of Flamborough is transported for this purpose to Whitby and other places on the coast, and a considerable

trade in lime is carried on at Hessle. The coralline oolite is burnt about Seamer. Ayton, Pickering, and Malton; and the Cave oolite at Hawsker, Maybecks, Commondale, Scugdale, Coxwold, Newborough Park, Brandsby, Westow, Sancton, Ellerker, &c. The lime from the oolites is less pure than that from the chalk, but all kinds are used in agriculture as well as for building.

Bricks are very generally used in Holderness and the vale of York, where the diluvial clay is an abundant and suitable material, and in Cleveland, where the lias clays furnish an additional supply. In the moorland valleys the shales might be employed for the same purposes, if the prevalence of sandstone did not render it unnecessary.

The nodules and layers of flint which occur in the chalk of the Wolds might be of value in the neighbourhood of potteries, but at present provide excellent materials for the roads. The basaltic dyke, the Bath oolite, slaty stone of Brandsby, and coral bed of the Pickering oolite, furnish very good stone for this use, and, in their absence, Holderness and the vale of York yield plenty of waterworn gravel.

Excepting limestone, the agriculturist employs none of the mineral productions of the eastern part of Yorkshire as manure. Possibly some varieties of the red and white marls near the mouth of the Tees might be available in this respect, as they are in the midland counties. In Holderness, the shell marl so generally found beneath the lacustrine deposits of peat, might, perhaps, be found useful if spread on the pastures; but it could hardly fail to produce excellent effects if spread upon the peat itself, in the mode adopted in the northern part of Lancashire. If this suggestion should be found correct, considerable benefit would result from the practice, for many such peaty hollows exist in the interior of Holderness, which can neither be obliterated by a covering of warp, nor corrected by ordinary industry.

EXPLANATION OF THE PLATES.

The geological map of the eastern part of Yorkshire is intended to convey a correct general idea of the relative situation and extent of the principal mineral masses; and though the scale to which it is drawn does not allow of minute accuracy, the outlines will be found sufficiently exact. I claim no merit for introducing the unconformed direction of the strata beneath the Wolds, the correct line of the Kimmeridge clay, nor that of the Bath oolite formation, because these points have been long since determined by Mr. Smith, who will, it is hoped, soon publish the results of his long and successful researches, on a splendid geological map of the county. The colours used on the map sometimes include a number of strata, which in the section have different tints assigned them. The diluvial gravel, clay, &c. of Holderness are represented by a bright purple, but it has not been deemed necessary to mark these accumulations in the vales of York, Pickering, and Cleveland. The white chalk is left uncoloured, but the red layers at its base are indicated by an appropriate narrow red line. The greenish blue, adopted from Mr. Smith, represents the great clay formation of the vale of Pickering, &c. of which the upper part corresponds to the gault, and the lower to the Kimmeridge clay. The coralline oolite formation occupies the space of the light orange, and the Oxford clay and Kelloways rock beneath range along the line of the dun purple. To have coloured across the moorlands the sub-divisions of the Bath oolite formation, which are visible on the coast, would have been hardly practicable; and the method of grouping them, as Mr. Greenough has done, has the great advantage of exhibiting at once the general analogy of these rocks and those in the south of England; whilst their differences may be easily gathered from the detailed sections. The bright yellow includes the cornbrash, upper sandstone and shale, Cave oolite, and lower sandstone and shale, whilst the inferior oolite, or dogger, is marked by the narrow stripe of full orange. The lias formation is coloured blue, and the new red sandstone, pink; the same bright purple is employed for the diluvium both in the map and in the sections; and the other colours in the latter are fully explained by references engraved on the plates, which also contain the necessary scales of altitude.

REFERENCE TO THE PLATES OF ORGANIC REMAINS.

The specimens figured in the following Plates are chiefly in the Collections of the Yorkshire Museum, Mr. Bean, Mr. Williamson, (since transferred to the Scarborough Museum) and the Author; a few were drawn from the Cabinets of Mr. Ripley, Mr. Lee, Mr. Cook, Mr. Preston, and the Whitby Museum, as indicated by the name after each species.

Plate I.—Chalk, page 90.

Fig.
1. Spongia plana. *Lee's Cabinet.*
2. .... capitata. *Author's Cabinet.*
3. .... osculifera. *York. Mus.*

Fig.
4. Spongia Benettiæ. *York. Mus.*
5. .... marginata. *Ditto.*
6. .... convoluta. *Ditto.*

Fig.
7. Spongia cribrosa. *Author's Cabinet.*
8. .... porosa. *York. Mus.*
8. *a.* .... lævis, with magnified parts of surface. *Auth.*
9. Spongia radiciformis. *Ditto.*
10. .... terebrata, with magnified view of interior. *York. Mus.*
11. Lunulites urceolata. *Ditto.*
12. Millepora globularis. *Ditto.*
13. Caryophyllia centralis. *Ditto.*

Fig.
14. Marsupites ornatus. *York. Mus.*
14. *a.* Plate of cidaris papillata, or cretosa. *Lee.*
15. Spatangus planus. *Bean.*
16. .... hemisphericus. *Will.*
17. Terebratula pentagonalis * (compare it with t. striatula, Pl. II. fig. 28.) *York. Mus.*
18. Belemnites Listeri. *Ditto.*
19. Serpula. *Ditto.*

Speeton Clay, page 93.

20, 21. Hamites maximus. It is a fine spiral shell. *Cook.*
22. Hamites intermedius. *Bean.*
23. .... raricostatus. *Will.*
24. .... rotundus. *Cook.*
25. Hamites attenuatus. *Bean.*
26, 27. ...... alternatus. *Ditto.*
28. Hamites Beanii. * *Ditto.*
29. .... plicatilis. *Will.*
30. .... Phillipsii. * *Bean.*

Plate II.—Speeton Clay.

1. Caryophyllia conulus. *York. Mus.*
2. Cidaris. *Will.*
3. Muricated spine of cidaris. *Ditto.*
4. Spatangus argillaceus. *Ditto.*
5. Granulated spine of cidaris. *Cook.*
6. Corbula punctum. *York. Mus.*
7. Tellina. *Ditto.*
8. Mya depressa. *Ditto.*
9. Pholadomya decussata. *Ditto.*
10. Nucula ovata. *Ditto.*
11. Nucula subrecurva. *Ditto.*
12. Nucula. *Ditto.*
13. Mya phascolina. *Bean.*
14. Lutraria. *York. Mus.*
15. Lucina sculpta. *Will.*
16. Cucullæa. *Bean.*
17. Pholas constricta. *Preston.*
18, 19. Astarte lævis. *Will.*
20, 21. Isocardia angulata. *York. Mus.*
22. Pinna gracilis. *Preston.*
23. Gryphæa sinuata. *York. Mus.*
24. Terebratula inconstans. *Ditto.*
25, 26. Terebratula subundata. *Ditto.*
27. Terebratula lineolata. *Bean.*
28. .... striatula. *York. Mus.*
29. Vermicularia Sowerbii. *Ditto.*
30. Serpula. *Ditto.*
31. Dentalium. *Will.*
32. Delphinula? *York. Mus.*
33, 34. Rostellaria Parkinsoni. *Ditto.*
35. Turbo pulcherrimus. *Ditto.*
36. Solarium tabulatum. *Bean.*
37. Trochus reticulatus. ? *York. Mus.*
38. Turritella. ? *Ditto.*
39. Melania. ? *Bean.*
40. Auricula obsoleta. *Ditto.*
41. Ammonites marginatus. *York. Mus.*
42. .... planus. *Ditto.*

Fig.
43. Ammonites nucleus. *York. Mus.*
44. .... hystrix. *Bean.*
45. .... rotula. *Yorkshire Mus.*
46. .... like a. parvus. *Ditto.*
47. .... concinnus. *Ditto.*
48. .... venustus. *Ditto.*
49. .... fissicostatus. *Will.*

Fig.
50. Ammonites curvinodus. *Wilson.*
51. Tooth of squalus.? *Ditto.*
52. .... of ichthyosaurus. *Ditto.*
53. .... of squalus.? *Ditto.*
54. Vertebra of ichthyosaurus. *York. Mus.*
55. Gyrodus minor. *Preston.*

Plate III.—Speeton Clay.

1. Belemnites jaculum. *Author's Cabinet.*
2. Astacus ornatus. *Auth.*
3. Claw of astacus mucronatus. *Bean.*

Coralline Oolite, page 98.

4. Turbinolia dispar. *Yorkshire Mus.*
5. Caryophyllia cylindrica. *Ditto.*
6. Astræa tubulifera. *Ditto.*
7. .... favosïoides. *Ditto.*
8. Spongia floriceps. *Ditto.*
9. Radical part of Rhodocrinus echinatus. *Ditto.*
10. The column with bifid side-arms. *Ditto.*
11. .... with the cicatrices of side arms. *Will.*
12. Cidaris florigemma. *York. Mus.*
13. Muricated spine of cidaris florigemma. *Yorkshire Museum.*
14. Smooth spine of cidaris intermedia. *Ditto.*
15. Echinus germinans. *Ditto.*
16. Clypeus dimidiatus. *Ditto.*
17. .... semisulcatus. *Ditto.*
18. .... emarginatus. *Ditto.*
19. Pholas recondita. *Cook.*
20. Modiola inclusa. *Yorkshire Mus.*
21. Astarte extensa. *Ditto.*
22. .... aliena. *Ditto.*
23. Cardita similis. *Ditto.*
24. Tellina ampliata. *Ditto.*
25. Astarte ovata. *Ditto.*
26. Trigonellites antiquatus. *Ditto.*
27. Corbula curtansata. *Ditto.*
28. Isocardia rhomboidalis. *Ditto.*
29. Arca æmula. *Ditto.*
30. Cucullæa contracta. *Ditto.*
31. .... triangularis. *Ditto.*
32. .... pectinata. *Ditto.*
33. .... elongata? *Ditto*
34. Cucullæa oblonga. *Ditto.*
35. Avicula expansa. *Ditto.*
36. Avicula ovalis. Lower valve. *Ditto.*

Plate IV.—Coralline Oolite.

1. Ostrea duriuscula. *Bean.*
2. Avicula elegantissima. *Ditto.*
3. Cardium lobatum. *Will.*
4. Nucula. *York. Mus.*
5. Psammobia lævigata. *Bean.*
6. Gryphæa? mima. *Will.*
7. Bulla elongata. *Ditto.*
8. Turritella muricata. *Will.*
9. Natica cincta. *Leeds Mus.*
10. Pecten inæquicostatus. *York. Mus.*
11. Turbo funiculatus. *Ditto.*
12. Orbicula radiata. *Ditto.*
13. Terebra melanioïdes. *Ditto.*
14. Turbo muricatus. *Ditto.*

Fig.
15. Serpula squamosa. *Bean.*
16. Trochus tornatilis. *Will.*
17. Vermicularia compressa. *Bean.*
18. Murex Haccanensis. *Will.*

Fig.
19. Ammonites Williamsoni. *Will.*
20, 21. Astacus rostratus. *York. Mus.*
22. Palatal teeth of a fish. *Ditto.*

Calcareous Grit, page 105.

23. Spatangus ovalis. *Bean.*
24. Clypeaster pentagonalis. *Ditto.*
25. Isocardia tumida. *Will.*
26. Venus. *Ditto.*
27. Actæon retusus. *Ditto.*
28. Cirrus cingulatus. *Bean.*
29. Ammonites solaris. *Will.*
30. Modiola bipartita. *York. Mus.*
31. Pholadomya simplex. *York. Mus.*
32. Rostellaria bispinosa. *Will.*
33. Pinna lanceolata. *York. Mus.*
34. Ammonites vertebralis. *Ditto.*
35. Serpula lacerata. *Will.*
36. Gryphæa bullata.? *York. Mus.*
37. Dentalium. *Will.*

Plate V.—Oxford Clay, page 109.

1. Sanguinolaria undulata. *York. Mus.*
2. Astarte lurida. *Ditto.*
3. .... carinata. *Ditto.*
4. Nucula (cast.) *Ditto.*
5. .... nuda. *Ditto.*
6. .... elliptica. *Bean.*
7. Pinna mitis. *York. Mus.*
8. Trigonellites politus. *Ditto.*
9. Cucullæa concinna. *Bean.*
10. Plagiostoma. *Ditto.*
11. Pecten. *York. Mus.*
12. Ostrea. *Will.*
13. .... inæqualis. *Bean.*
14. Rostellaria trifida. *York. Mus.*
15. Belemnites gracilis. *Ditto.*
16. Ammonites oculatus. *Bean.*
17. Ammonites. *York. Mus.*
18. Unknown. *Bean.*
19. Ammonites Vernoni. *York. Mus.*
20. Claw of astacus. *Bean.*
21. Serpula intestinalis. *Will.*
22. Tooth of squalus.? *Ditto.*

Kelloways Rock, page 111.

23. Mya. *York. Mus.*
24. Pholadomya obsoleta. *Ditto.*
25. Amphidesma recurvum. *Ditto.*
26. Modiola pulchra. *Ditto.*
27. Cardium dissimile.? *Ditto.*
28. Variety of modiola cuneata.? *York. Mus.*
29. Corbis ovalis. *Bean.*
30. Astarte. *York. Mus.*
31. Cucullæa concinna. *Ditto.*
32. Corbis lævis.? *Ditto.*

Plate VI.—Kelloways Rock.

1. Gryphæa dilatata, var. β *York. Mus.*
2. Plagiostoma duplicatum (cast.) *Bean.*
3. Pecten fibrosus. *Ditto.*
4. Ostrea undosa. *Bean.*
5. Pecten demissus. *Ditto.*
6. Avicula Braamburiensis. *York. Mus.*

Fig.
7. Terebratula ornithocephala. *York.Mus.*
8. .... socialis. *Ditto.*
9. Ostrea archetypa. *Ditto.*
10. Turbo sulcostomus. *Ditto.*
11. Lucina lirata. *Auth.*
12. Cirrus depressus. *Bean.*
13. Rostellaria bispinosa. *Will.*
14. Trochus guttatus. *Ditto.*
15. Ammonites Calloviensis. *York. Mus.*
16. .... Duncani. *Ditto.*

Fig.
17. Ammonites gemmatus. *Author's Cab.*
18. .... bifrons. *Ditto.*
19. .... athleta. *Ditto.*
20. .... flexicostatus. *Ditto.*
21. .... Gowerianus. *Ditto.*
22. .... sublævis. *Ditto.*
23. .... funiferus. *Ditto.*
24. .... Kœnigi. *Ditto.*
25. .... lenticularis. *Ditto.*

Plate VII.—Cornbrash, page 115, *&c.*

1. Cidaris vagans. *York. Mus.*
2. Clypeus clunicularis. *Ditto.*
3. .... orbicularis. *Auth.*
4. Galerites depressus. *York. Mus.*
5. Mya literata. *Ditto.*
6. Isocardia minima. ? *Ditto.*
7. Cardium citrinoïdeum. *Ditto.*
8. Cellaria Smithii. *Ditto.*
9. Pholadomya Murchisoni. *York. Mus.*
10. Amphidesma securiforme. *Ditto.*
11. .... decurtatum. *Ditto.*
12. Unio peregrinus. *Ditto.*
13. Plagiostoma rigidulum. *Ditto.*
14. .... interstinctum. *Will*
15. Melania vittata. *Ditto.*
16. Terebra granulata. *Ditto.*

Upper Sandstone, &c. page 118.

17. Sphænopteris ? longifolia. *Bean.*
18. .... ? latifolia. *Ditto.*
19. Cycadites tenuicaulis. *Ditto.*
20. .... comptus. *York. Mus.*
21. .... sulcicaulis. detached figures of the upper and under sides of the base of the leaf. *Dr. Murray.*
22. Cycadites pecten. *Bean's Cabinet.*
23. Unknown leaves. *Ditto.*
24. .... leaf. *Ditto.*
25. Small vegetable bodies in groups. *Ditto.*

Plate VIII.—Upper Sandstone, Shale, and Coal.

1. Spike of Lycopodites. *Bean.*
2. Winged seed. *Ditto.*
3. Lycopodites uncifolius. *Will.*
4. Aspleniopteris Nilsoni ? *Bean.*
5. Scolopendrium solitarium. *York. Mus.*
6. Sphænopteris digitata. *Will.*
7. Variety of ditto. *Ditto.*
8. Pecopteris paucifolia. *Bean.*
9. Phyllites nervulosus. *Bean.*
10. Pecopteris cæspitosa. *Ditto.*
11. .... crenifolia. *Ditto.*
11. *a.* magnified seed vessels. *Ditto.*
12. Pecopteris curtata, with a granulated surface. *Ditto.*
13. Neuropteris lobifolia. *Preston.*
14. Pecopteris ligata. *York. Mus.*

Fig.
15. Pecopteris recentior. *Will.*
16. .... exilis. *York. Mus.*
17. Pecopteris hastata. *Will.*
18. A skeletonized fern branch. *Bean.*

Plate IX.—Oolite of Cave, Brandsby, &c., page 121.

1. Millepora straminea. *York. Mus.*
2. Retepora. ? *Ditto.*
3. Smooth spine of cidaris. *Ditto.*
4. Muricated spine of cidaris. *Ditto.*
5. Spine of cidaris maximus. *Ditto.*
6. Lutraria gibbosa ? *Bean's Cabinet.*
7. Pholadomya nana. *Ditto.*
8. Lucina despecta. *Ditto.*
9. Isocardia angulata ? *Ditto.*
10. .... nitida. *Ditto.*
11. Nucula variabilis. *Ditto.*
12. Cytherea dolabra (small specimen.) *Ditto.*
13. Pullastra recondita. *Ditto.*
14. Cardium cognatum. *Ditto.*
15. .... semiglabrum. *Ditto.*
16. Corbula depressa. *Ditto.*
17. Pinna cuneata. *Ditto.*
18. Terebratula spinosa. *York. Mus.*
19. Cucullæa imperialis. *Bean.*
20. Cucullæa cylindrica. *Phil.*
21, 22. Perna quadrata. *Will.*
23. Astarte minima. *York. Mus.*
24. Cucullæa cancellata. *Bean.*
25. Nucula lachryma (obtuse var.) *York. M.*
26. Gryphæa. *Ditto.*
27. Terebra vetusta. *Will.*
28. Rostellaria composita. *Bean.*
29. Phasianella cincta. *Ditto.*
30. Natica adducta. *Ditto.*
31. Actæon glaber. *Ditto.*
32. Delphinula. ? *York. Mus.*
33. Trochus monilitectus. *Bean.*
34. Vermicularia nodus. *York. Mus.*
35. Ostrea sulcifera. *Ditto.*
36. Gervillia acuta. *Ditto.*
37. Pecten abjectus. *Ditto.*
38. Belemnites quinquesulcatus. *Ditto.*

Plate X.—Lower Sandstone, Shale, and Coal, page 125, *&c.*

1. Cycadites latifolius. *York. Mus.*
2. .... gramineus. *Ditto.*
3. .... lanceolatus. *Ditto.*
4. .... pectinoïdes. *Ditto.*
5. Winged seed. *Phil.*
6. Sphænopteris lanceolata. *York. Mus.*
7. Pecopteris curtata. *Ditto.*
8. Sphænopteris stipata. *York. Mus.*
9. Neuropteris lævigata. *Ditto.*
10. Sphænopteris muscoides. *Ditto.*
11. Thuites expansus ? *Ditto.*
12. Flabellaria ? viminea. *Ditto.*
13. Equisetum laterale. *Ditto.*

Plate XI.—Inferior Oolite, page 127, *&c.*

1. Caryophyllia convexa. *Bean.*
2. Cidaris. *Ditto.*
3. Mya calceiformis. *Bean.*
4. ...... dilata. *Whitby Mus.*

Fig.
5. Cardium incertum. *Bean's Cabinet.*
6. .... acutangulum. *Ditto.*
7. .... striatulum. *Ditto.*
8. .... gibberulum. *Ditto.*
9. Variety of modiola aspera. ? *Ditto.*
10, 11. Astarte. *Ditto.*
12. Mya æquata. *Ditto.*
13. Nucula axiniformis. *Ditto.*
14. .... lachryma. *Ditto.*
15. Pallustra oblita. *Ditto.*
16. Gervillia lata. *Ditto.*
17. Hinge of ditto. *Ditto.*
18. Cucullæa reticulata. *Ditto.*
19. Nucula variabilis. *York. Mus.*
20. Pecten virguliferus. *Bean.*
21. Mytilus cuneatus. *Ripley.*
22. Trochus pyramidatus. *Bean.*
23. Turritella quadrivittata. *Ditto.*
24. Lingula Beanii. *York. Mus.*
25. Natica tumidula. *Bean.*

Fig.
26. Serpula deplexa. *York. Mus.*
27. Trochus bisertus. *Will.*
28. Turritella cingenda. *York. Mus.*
29. Mouth of ditto. *Ditto.*
30. Solarium calix. *Ditto.*
31. Turbo lævigatus. *Bean.*
32. Nerita costata. *York. Mus.*
33. Auricula Sedgvici. *Bean.*
34. Actæon humeralis. *Ditto.*
35. Natica adducta. *York. Mus.*
36. Gastrochæna tortuosa. *Ditto.*
37. Vermicularia compressa. *Ditto.*
38. Trigonia striata. *Ditto.*
39. Cardita similis. *Ditto.*
40. Isocardia concentrica. *Ditto.*
41. Astarte elegans. *Ditto.*
42. Unio abductus. *Ditto.*
43. Cucullæa elongata. *Bean.*
44. .... cancellata. *Ditto.*

Plate XII.—Upper Lias Shale, page 132, *&c.*

1. Basal and posterior view of the cranium of a small crocodile. *York. Mus.*
2. Lateral view of the head of a saurian animal: a vertical aperture on the head. ? *Ditto.*
3. Corbis uniformis.
4. Nucula ovum. *York. Mus.*
5. Amphidesma donaciforme. *Ditto.*
6. .... rotundatum. *Ditto.*
7. Cardium (cast.) *Auth.*
8. Nucula complanata (cast.) *Ditto.*
9. Sanguinolaria elegans. *York. Mus.*
10. Conularia quadrisulcata, probably from Coalbrook Dale, though said to be from Whitby. *Auth.*
11. Actæon. *York. Mus.*
12. Rostellaria ? *York. Mus.*
13. Plagiostoma pectinoïdeum (a small specimen.) *Ditto.*
14. Variety of inoceramus dubius. *Phil.*
15. Ammonites crassus (variety, with tubercles.) *York. Mus.*
16. Nautilus astacoïdes, Young and Bird. (lineatus ? Min. Conch.) *Ditto.*
17. Ammonites balteatus. *Whitby Mus.*
18. Nautilus annularis. *Ditto.*
19. Ammonites heterogeneus. *Ditto.*
20. Belemnites tubularis, in three portions, (compressed at each end.) *York. Mus.*
21. Belemnites compressus. *Ditto.*
22. Ammonites crenularis. *Ditto.*

Plate XIII.—Upper Lias Shale.

Fig.
1. Ammonites vittatus. *York. Mus.*
2. .... heterophyllus. *Ditto.*
3. .... subcarinatus. *Ditto.*
4. .... sigmifer. *Auth.*
5. .... Conybeari ? jun. *Y. Mus.*
6. .... Lythensis. *Ditto.*
7. .... exaratus. *Ditto.*

Fig.
8. Ammonites Hawskerensis. *York. Mus.*
9. .... arcigerens. *Ripley.*
10. .... ovatus. *York. Mus.*
11. .... maculatus. *Ditto.*
12. .... elegans. ? *Ditto.*
13. .... erugatus. *Bean.*

Marlstone and Ironstone Series, page 132.

14. Cardium truncatum. *York. Mus.*
15. Pholadomya obliquata. *Ditto.*
16. Pullastra antiqua. *Bean.*
17. Spine of cidaris. *Will.*
18. Turbo undulatus. *Bean.*
19. Ammonits anguliferus. *York. Mus.*
20. Ophiura Millcri. *York. Mus.*
21. Cardium multicostatum. *Bean.*
22. Terebratula triplicata. *York. Mus.*
23. .... resupinata. *Ditto.*
24. .... bidens. *Ditto.*
25. .... acuta. *Ditto.*

Plate XIV.—Marlstone Series.

1. Sanguinolaria vetusta. *Bean.*
2. Modiola scalprum. *York. Mus.*
3. Avicula cygnipes. *Ditto.*
4. .... inæquivalvis. *Ditto.*
5. Pecten sublævis. *York. Mus.*
6. Ammonites Clevelandicus. *Ditto.*
7. Gryphæa depressa. *Ditto.*
8. Dentalium giganteum. *Ditto.*

Lower Lias Shale, page 132.

9. Ammonites geometricus. *Ripley.*
10. Natica. *York. Mus.*
11. Trigonia literata. *Will.*
12. Corbula cardioïdes. *Bean.*
13. Ammonites Bucklandi, jun. *York. Mus.*
14. Ammonites Turncri ? *Ditto.*
15. Plicatula spinosa. *York. Mus.*
16. Serpula capitata. *Bean.*
17. Pinna folium. *York. Mus.*
18. Plagiostoma. *Bean.*

FINIS.

(*Thomas Wilson and Sons, High-Ousegate, York.*)

Note on Page 40.

The impression of this Edition had been some time completed, and the colouring of the plates nearly executed, when I had the pleasure to learn that the obscurity hanging over the interesting question of the existence of Tertiary deposits on the Yorkshire Coast, had been dissipated by a recent discovery of tertiary shells by my indefatigable friend Mr. Bean, near the spot where Professor Sedgwick and myself had sought for them without success. The following notice has been communicated by Mr. Bean to the Magazine of Natural History for June, 1835.

'Being on a geological excursion ten days ago, (from March 30), in the neighbourhood of Bridlington Quay, Mr. Walter Wilson, an intelligent lapidary of that place, directed my attention to a deposit of fragile and broken shells which the late high tides had exposed on the north side of the harbour, and near the pleasure ground called the 'Esplanade.' Ere I visited the place, I expected to find one of the lacustrine deposits so very common on this coast. On arriving at the spot, a heterogeneous mass, only a few yards long, and as many high, presented itself, composed of sand, clay, marine shells, and pebbles of every description; chalk and flint pebbles were, as might be expected, the most abundant. I hastily procured a few specimens of shells, and was delighted to find my anticipations in this respect had not been realized.

In colour and appearance this shelly mass resembled the London clay, but the fossils bore the aspect of those found in the Crag:—(the shelly bed contains) a greater number of species than have been at present obtained, and much caution will be requisite ere its geological relations can be truly determined. Thus much however is certain that these shells are coeval with, if not of higher antiquity than, the Crag.

Mr. Phillips in his excellent *Illustrations of the Geology of Yorkshire* mentions a somewhat similar deposit near Hedon; but all the shells he has recorded are at present inhabitants of our seas, whereas more than half of those I have procured cannot be referred to any existing species. I intend shortly to publish a more detailed account, with a list of all the species, and figures and descriptions of those that are undescribed.

Shells of the following genera have occurred:—Dentalium, balanus, pholas, mya, corbula, saxicava, (a large rugged shell), psammobia, tellina, astarte, (four species), cyprina, cytherea, venericardia, cardium, nucula, (two species, one large and beautiful,) mytilus, pecten, (two species), ostrea, ? natica, (two species), scalaria, turbo, (a fine pearly shell,) littorina, turritella, fusus, (four species.)

I have again visited this place in company with Dr. Murray; we reaped a rich and abundant harvest, and I was rejoiced to find the opinion I had previously formed immediately assented to by so able and experienced a geologist.'

ERRATA.

Page 91, line 14, for *vent* read *vertex*.

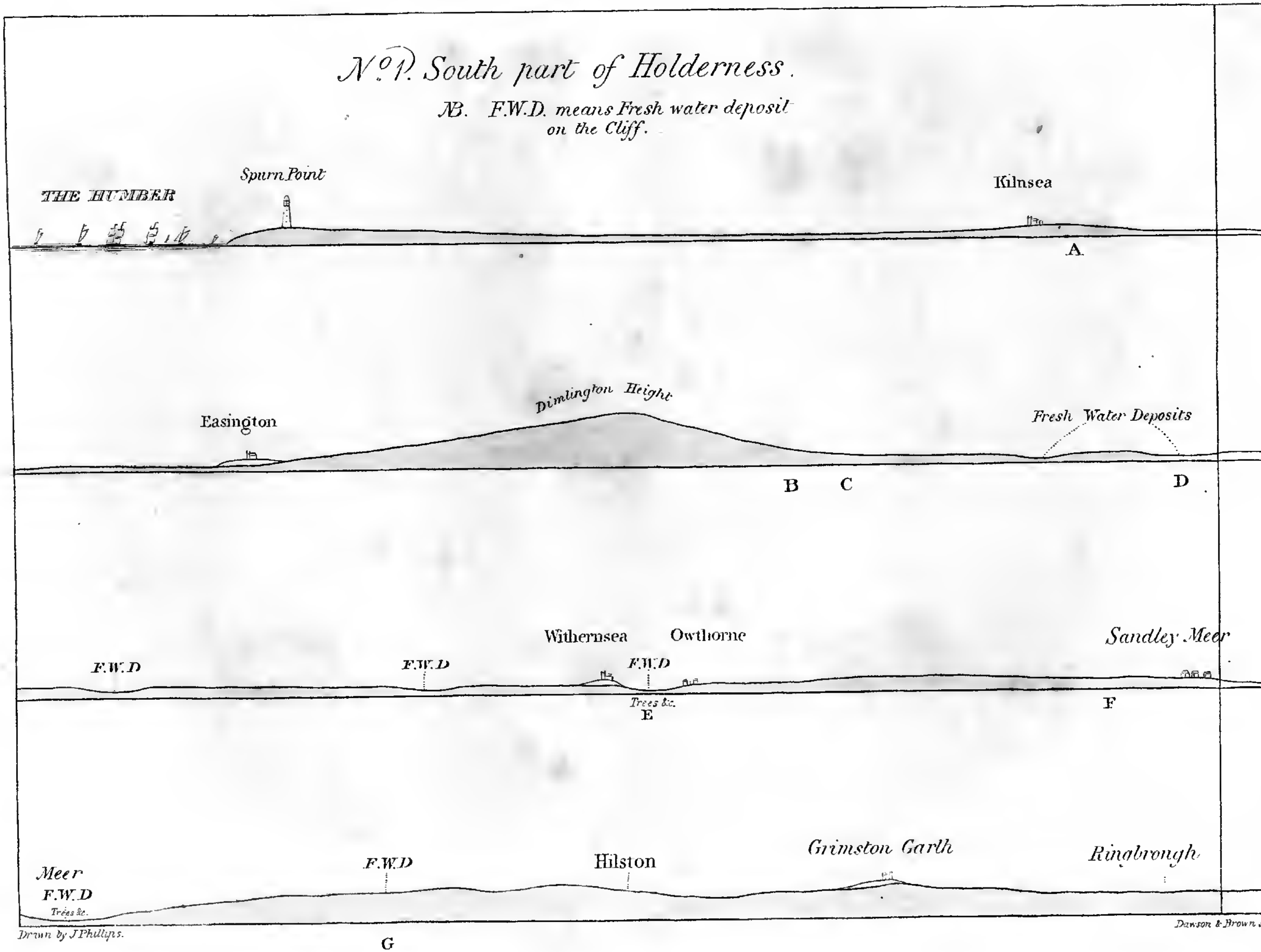
119. Head-line, for *Fossils of the White Chalk* read *Fossils of the Upper Sandstone and Shale*.

156. For *Clypeus sulcatus* read *Cl. sinuatus*.
The reference to Parkinson for cidaris papillata should be O. R. iii. 1, 11.

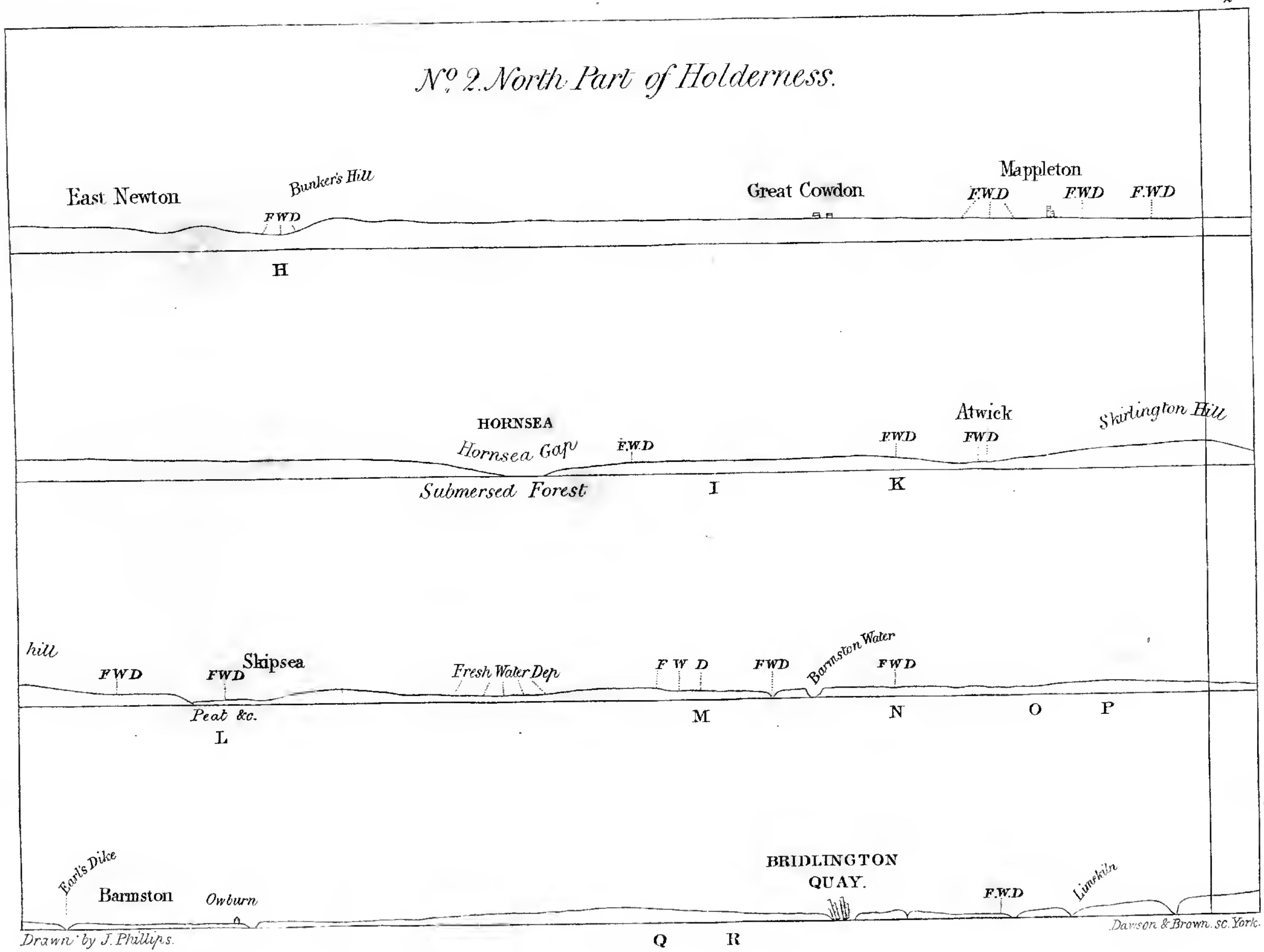
177. In the reference to Cabinets insert the name of *Dr. Murray*.

179. After (Tooth of Squalus) for *Ditto* read *Yorkshire Museum*.

SECTION OF THE CLIFFS on the COAST OF YORKSHIRE.

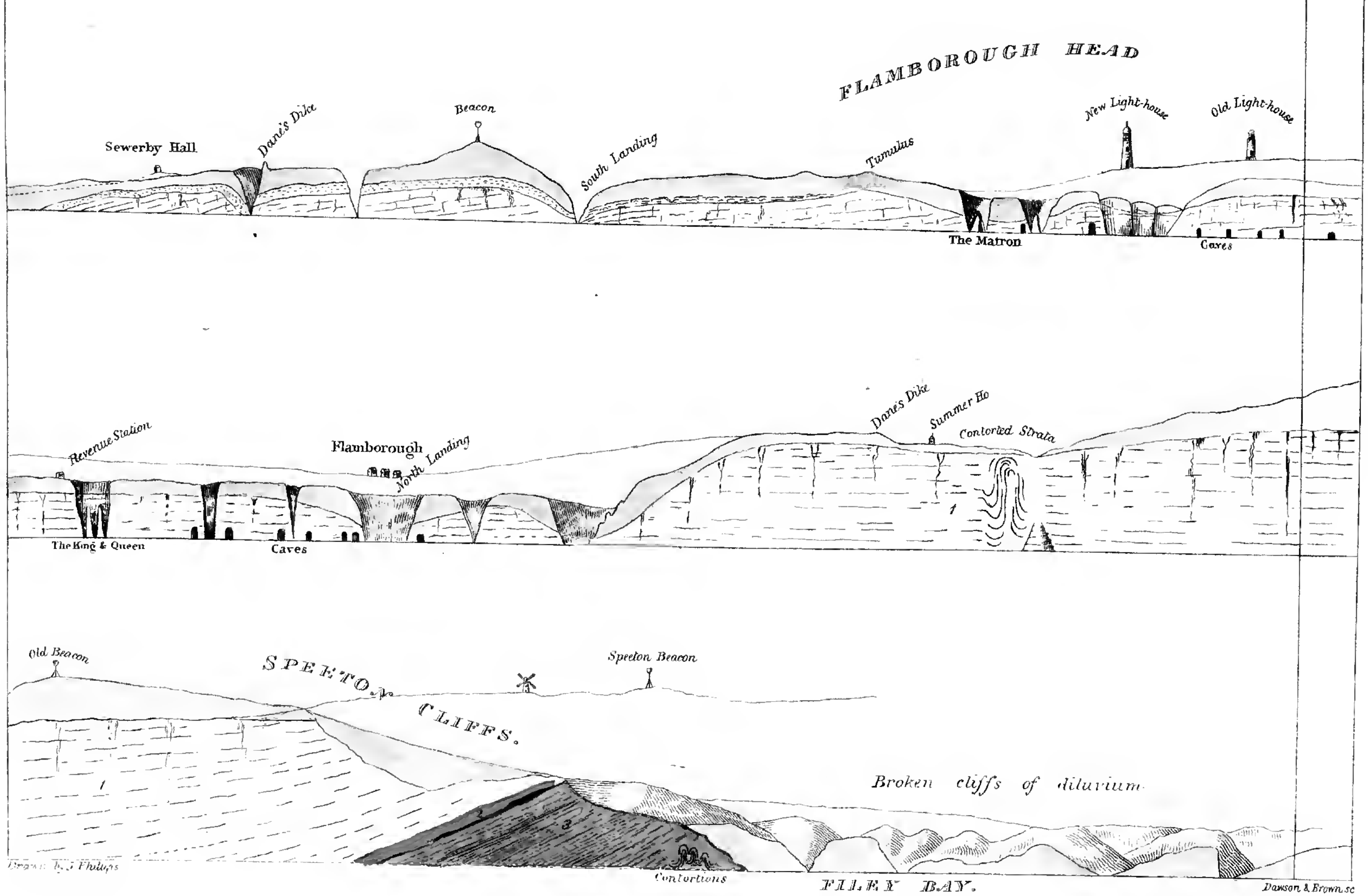


Drawn by J. Phillips. Dawson & Brown sc.


No. 2. North Part of Holderness.
East Newton
Bunker's Hill
FWD
H
Great Cowdon
Mappleton
F.W.D
FWD
F.WD
HORNSEA
Hornsea Gap
F.W.D
Submersed Forest
I
FWD
K
Atwick
FWD
Skirlington Hill
hill
FWD
FWD
Skipsea
Peat &c.
L
Fresh Water Dep.
F W D
M
FWD
Barmston Water
FWD
N
O
P
Earl's Dike
Barmston
Owburn
BRIDLINGTON QUAY.
F.W.D
Linekiln
Q
R
Drawn by J. Phillips.
Dawson & Brown. sc. York.

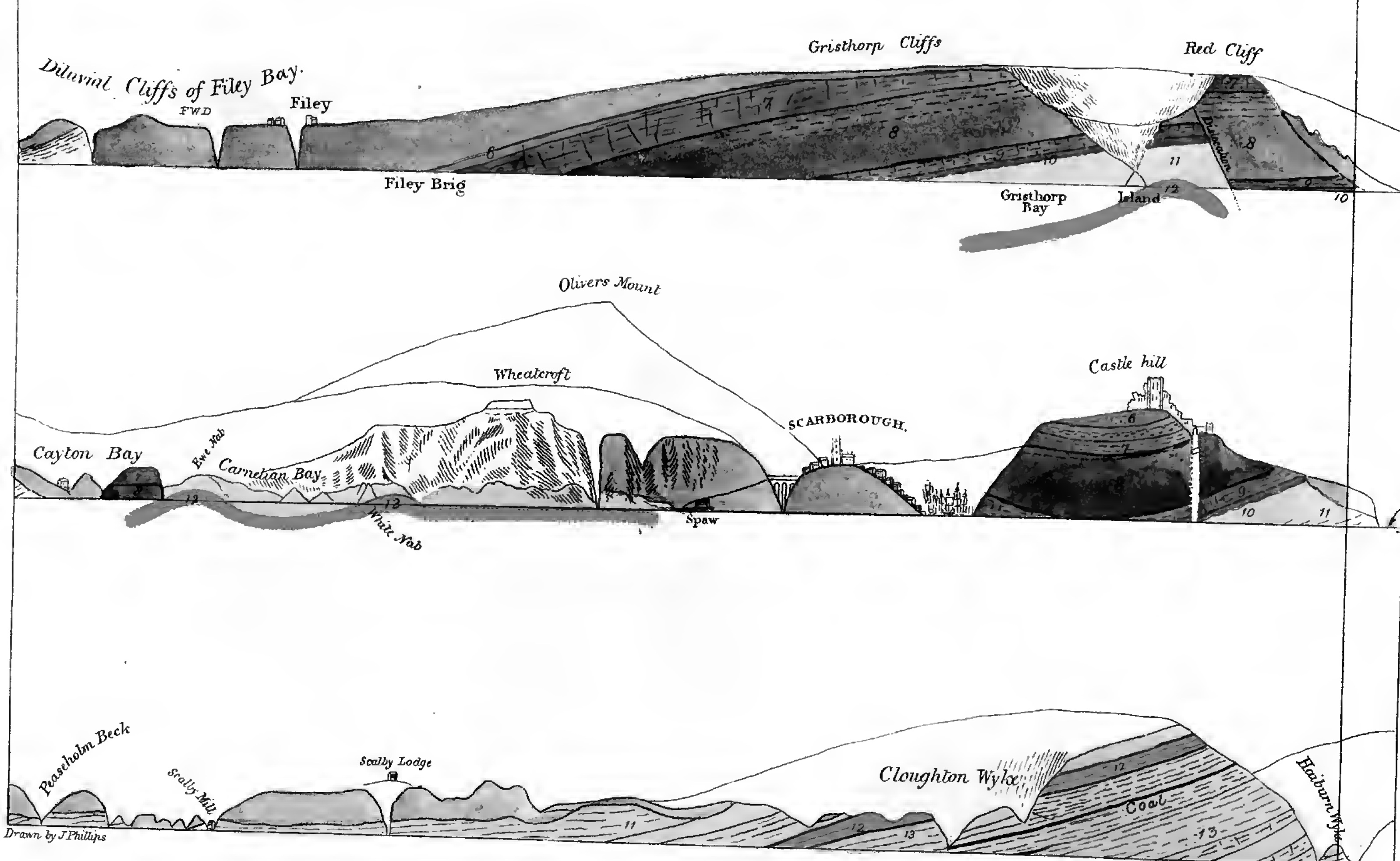
No. 3. Between BRIDLINGTON and FILEY.

No. 1. Chalk, 2. Red Chalk, 3. Gault.



No. 4. From FILEY to HAIBURN WYKE.

No. 6. Coralline Oolite. 7. Calcareous Grit. 8. Oxford Clay. 9. Kelloways Rock. 10. Cornbrash. 11. Upper Shale, and Sandstone. 12. Oolitic Limestone. 13. Lower Shale and Sandstone.



Drawn by J. Phillips

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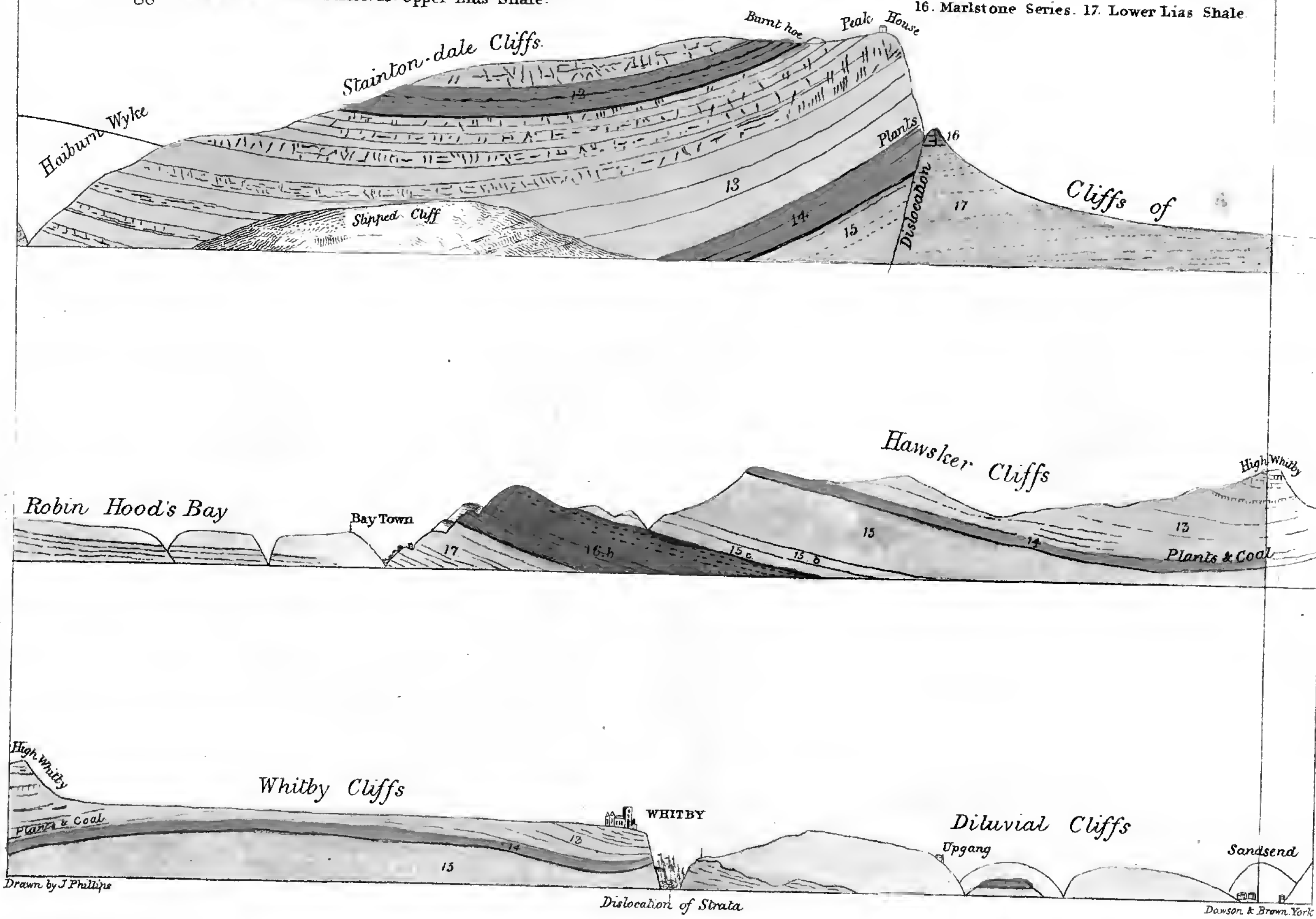
№ 5. From HAIBURN WYKE to SANDSEND.



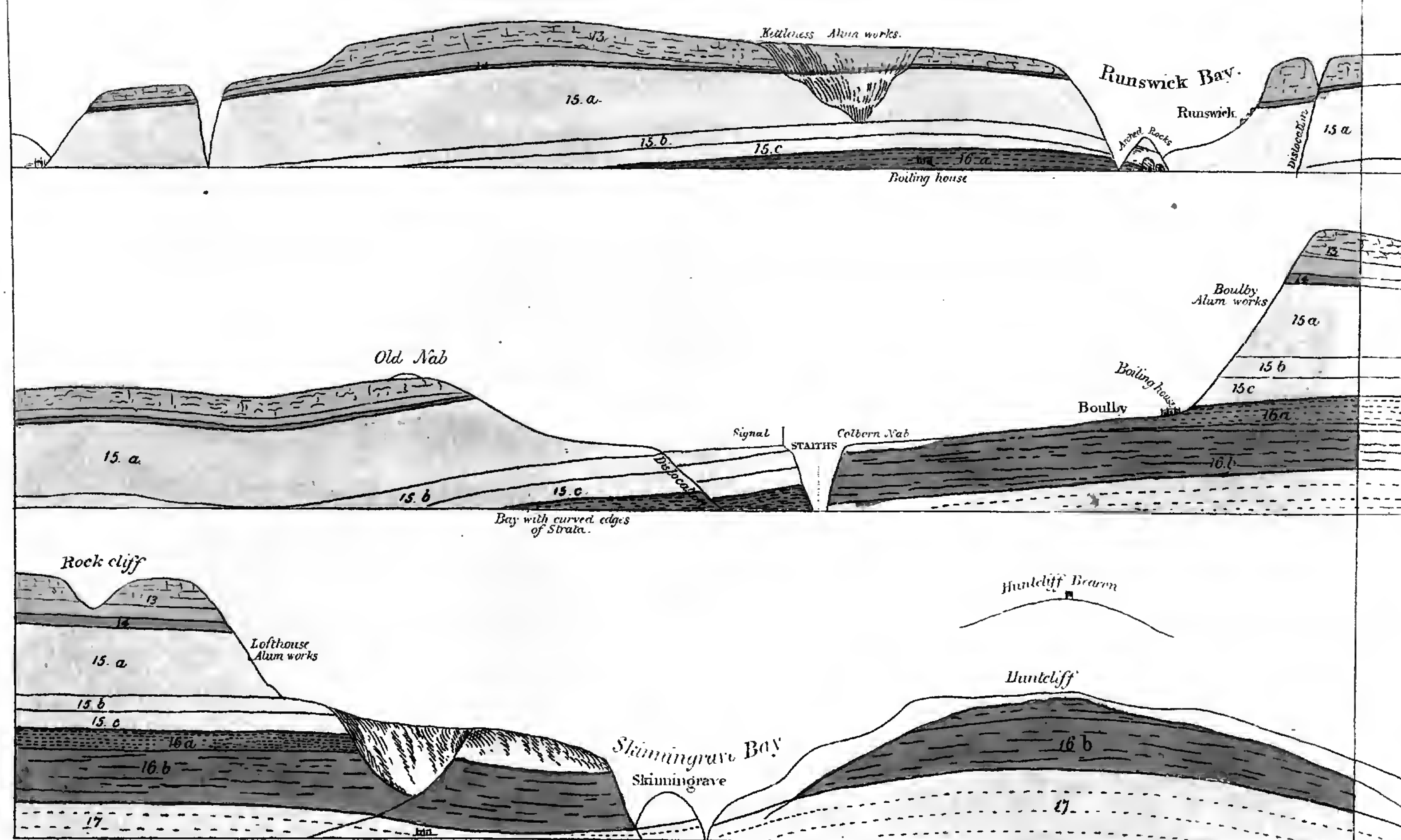
Drawn by J. Phillips

Dawson & Brown, York

No 6. Between SANDSEND and SALTBURN.

15. a. b. & c. Upper Lias Shale & its divisions. 16. a. & b. Ironstone & Marlstone Series.

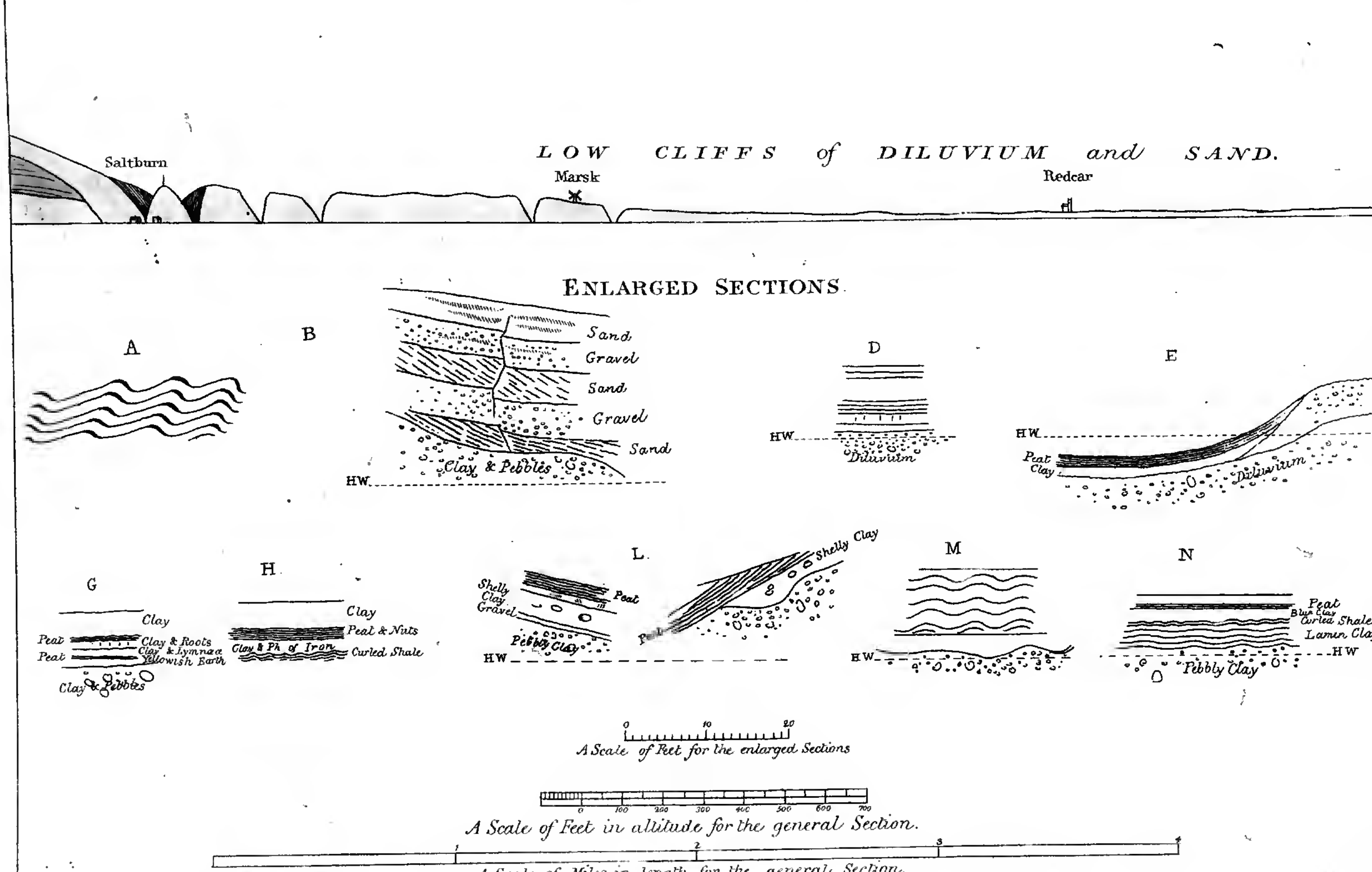
17. Lower Lias Shale.



Drawn by J. Phillips.

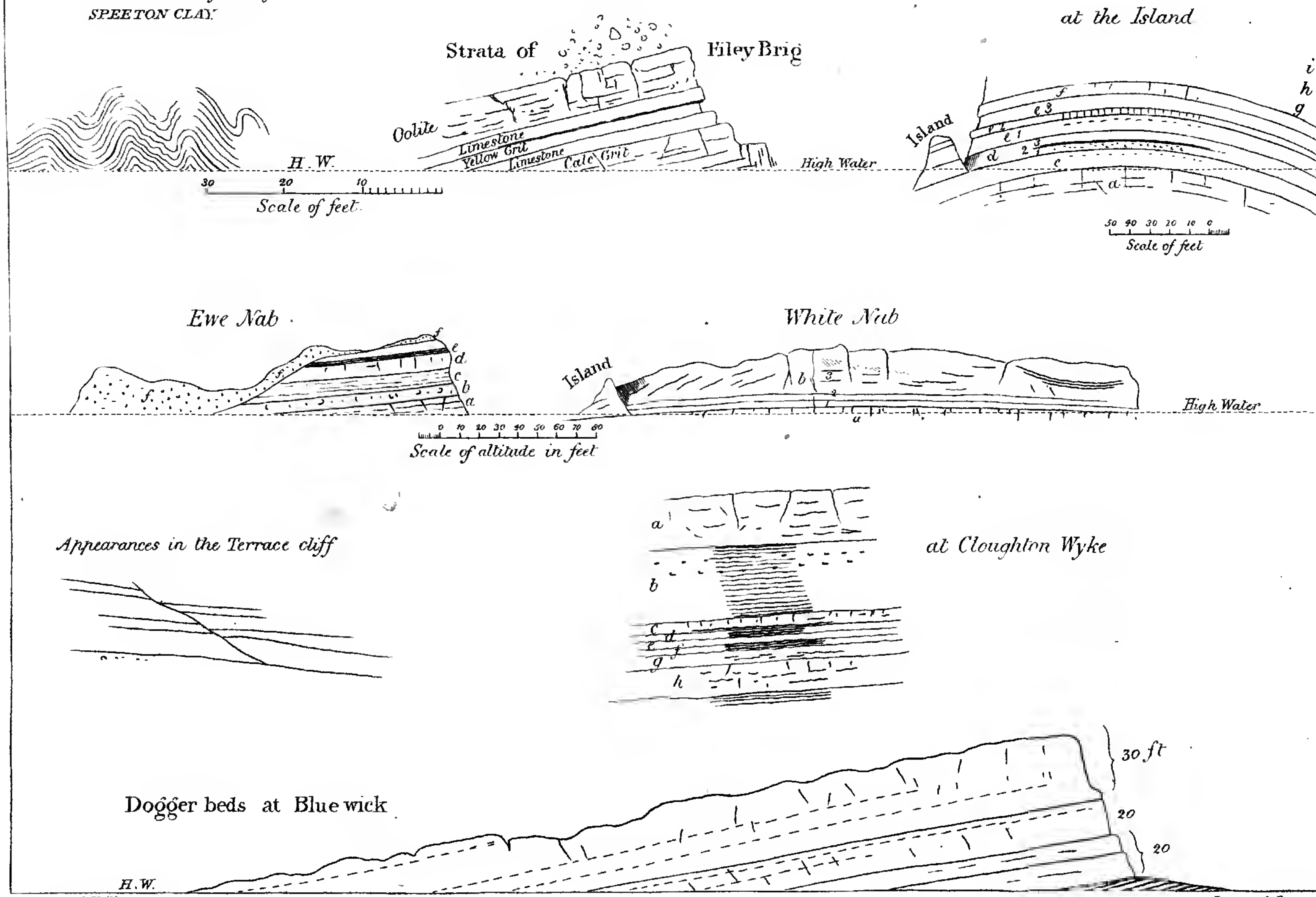
Dawson & Brown, sc.

No. 7. COAST near REDCAR.



Drawn by J. Phillips. Dawson & Brown sc.

Nº 8. ENLARGED SECTIONS.



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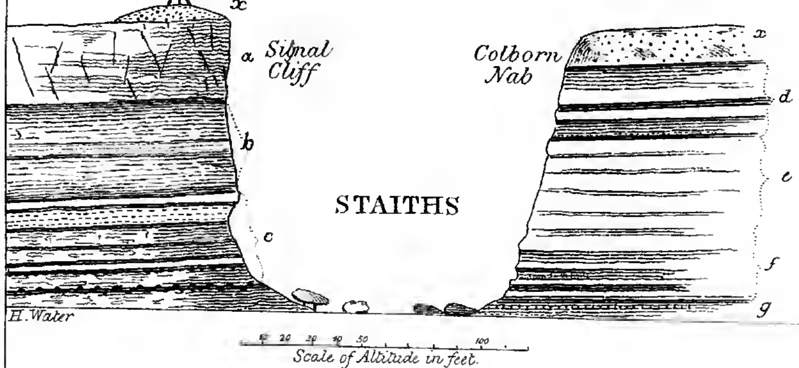
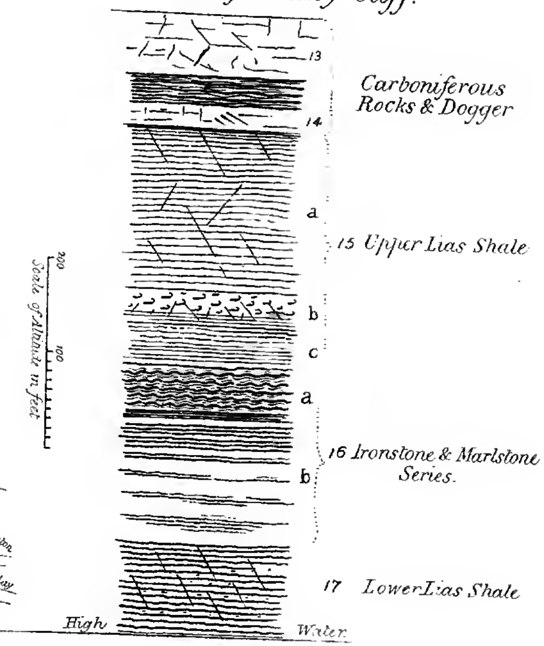
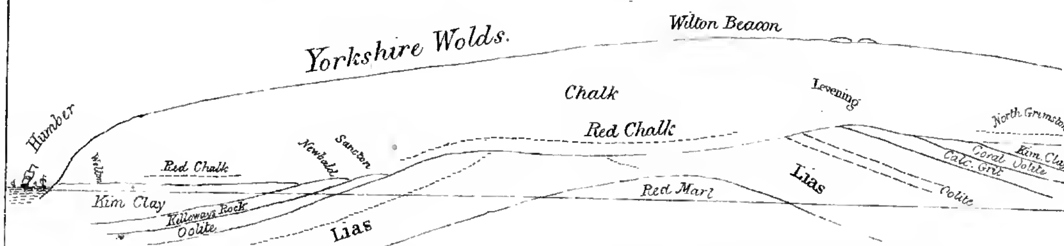
N° 9. ENLARGED SECTIONS.



General Section of Boulby Cliff.

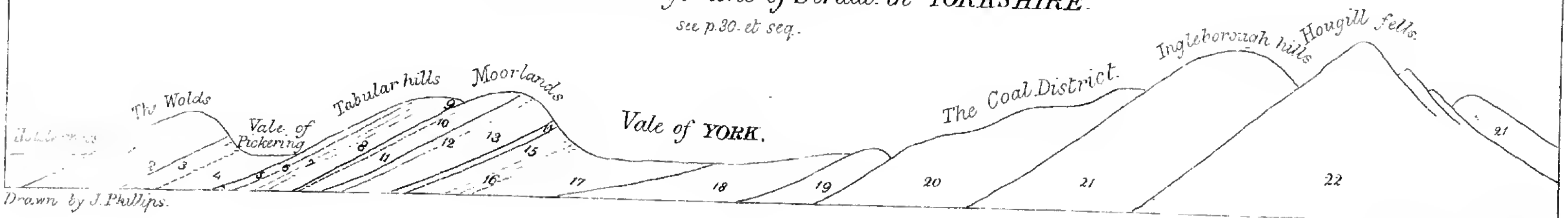




Unconformed Stratification beneath the Wolds.

General Arrangement of Strata in YORKSHIRE.

see p.30. et seq.



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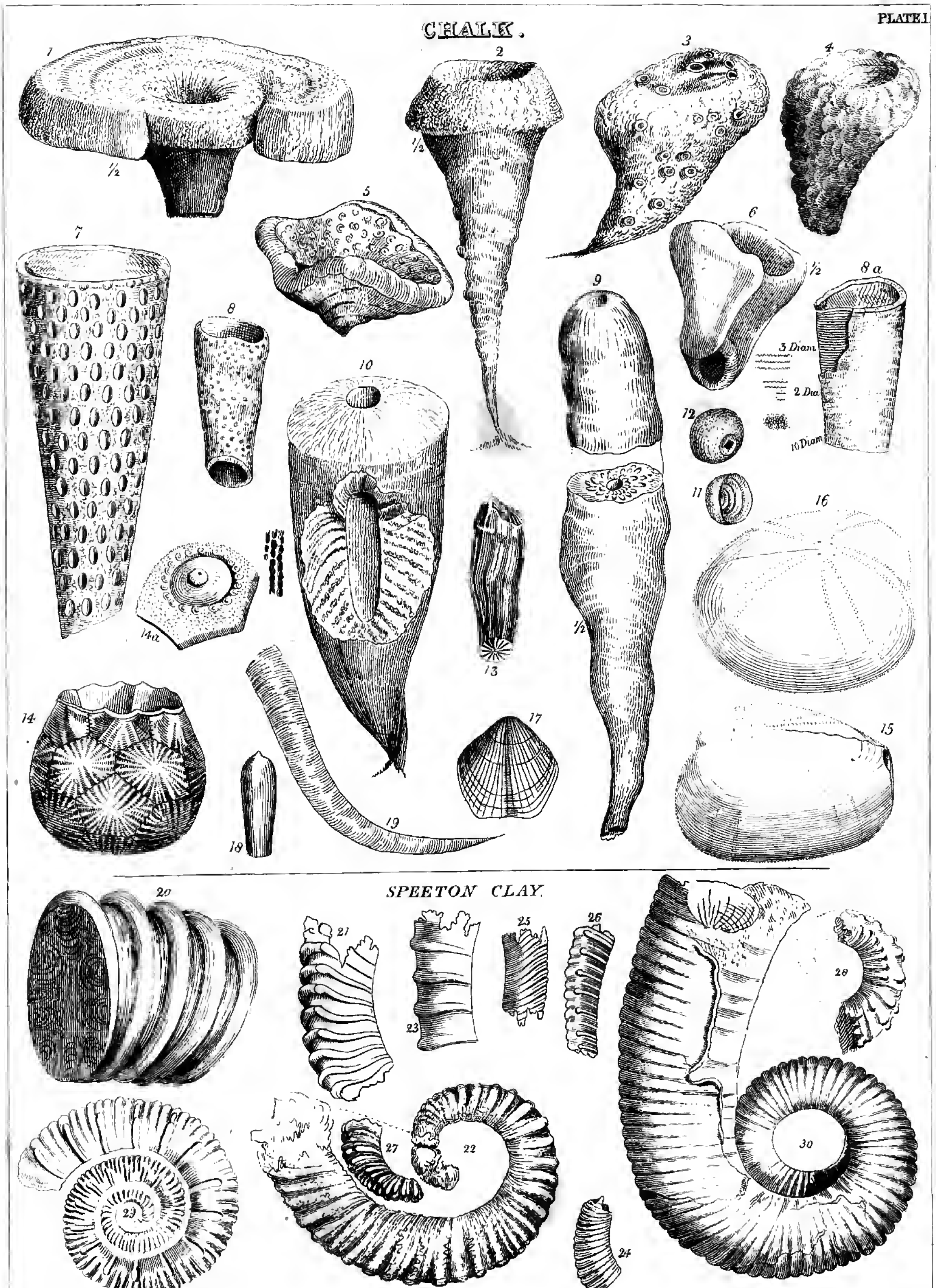
Dawson & Brown sc York



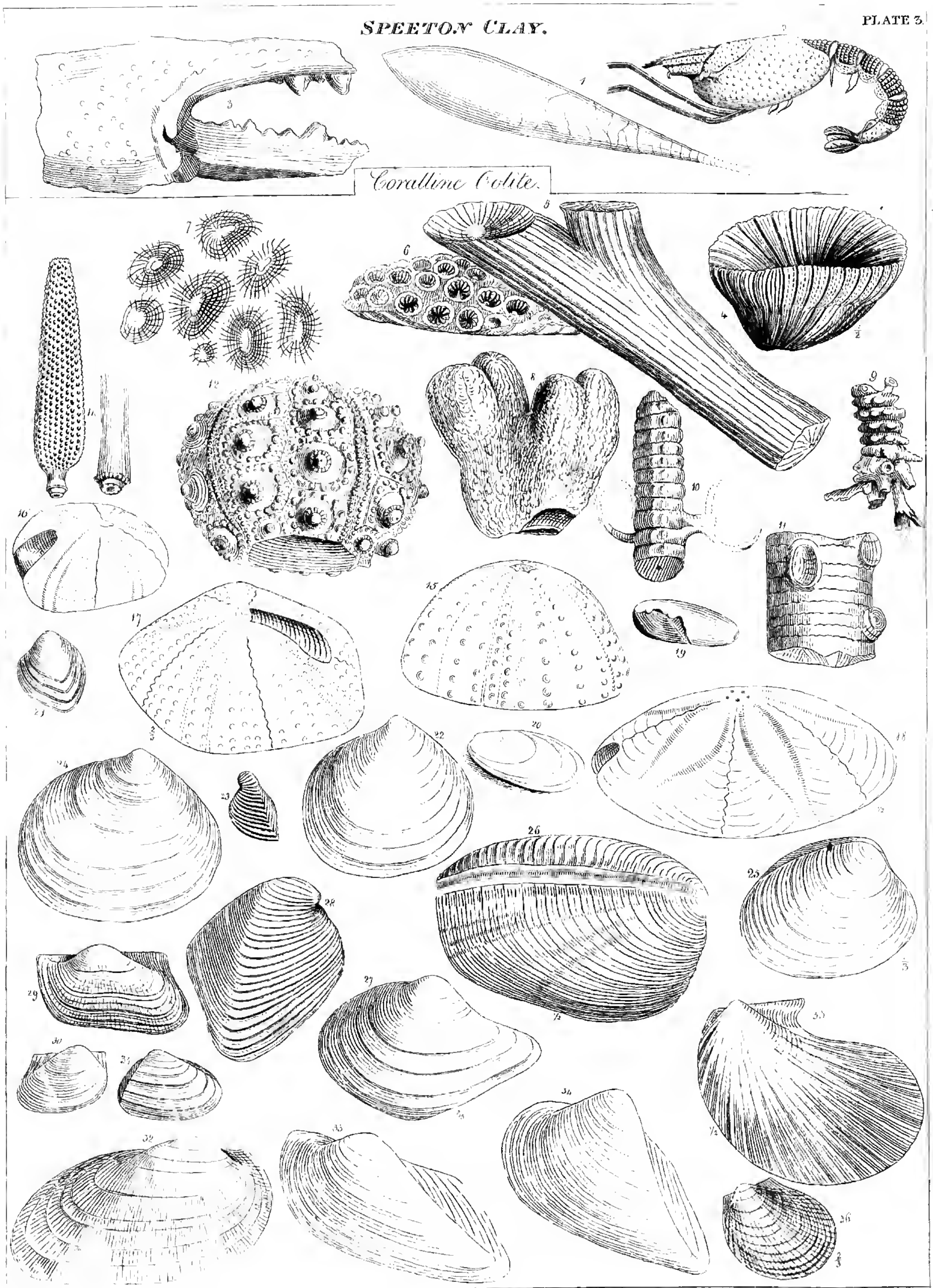
Drawn by J. Phillips.

Dawson & Brown sc. York.

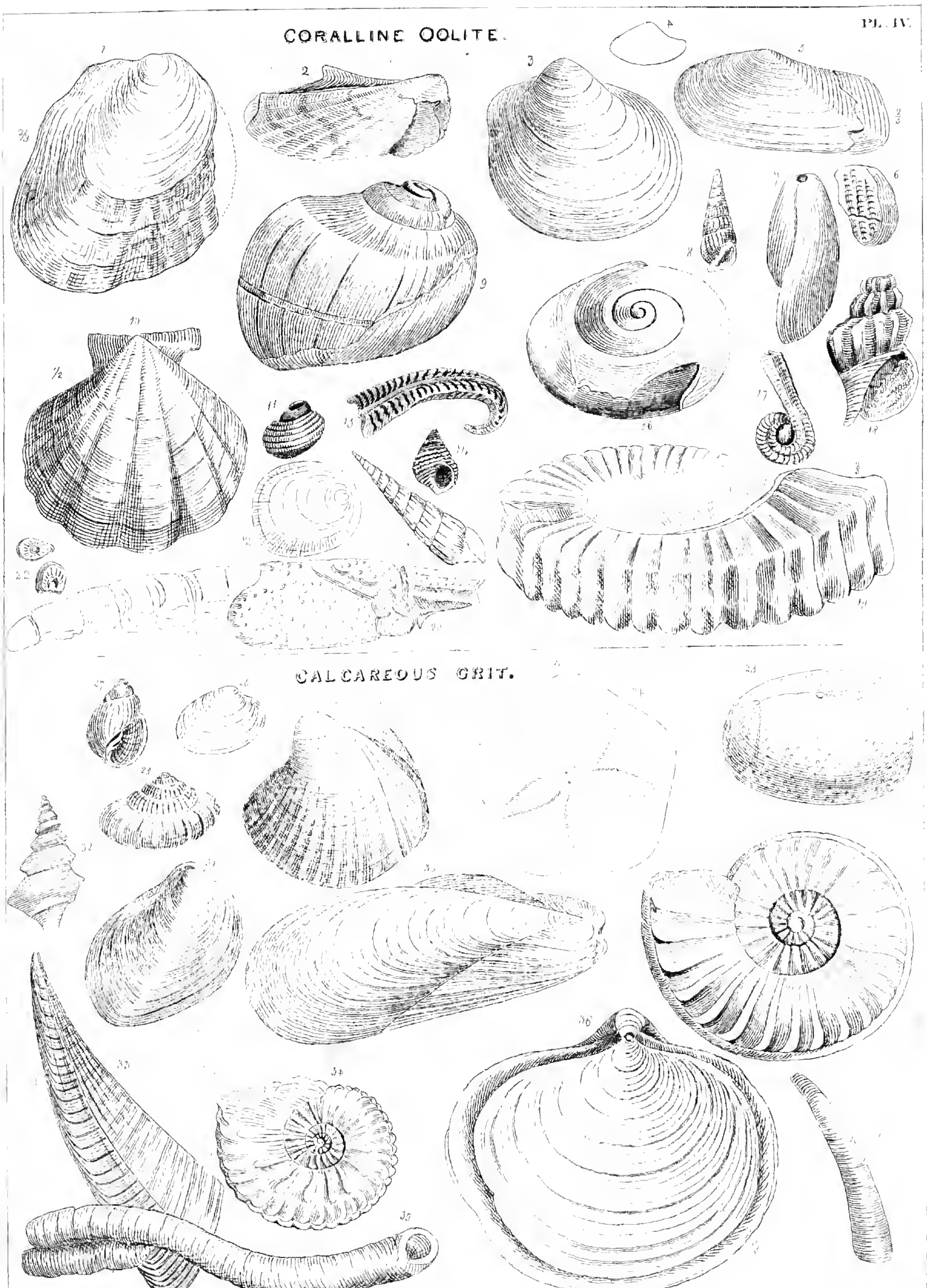
SPEETON CLAY.

Drawn by J. Phillips

Engraved by Dawson & Brown.

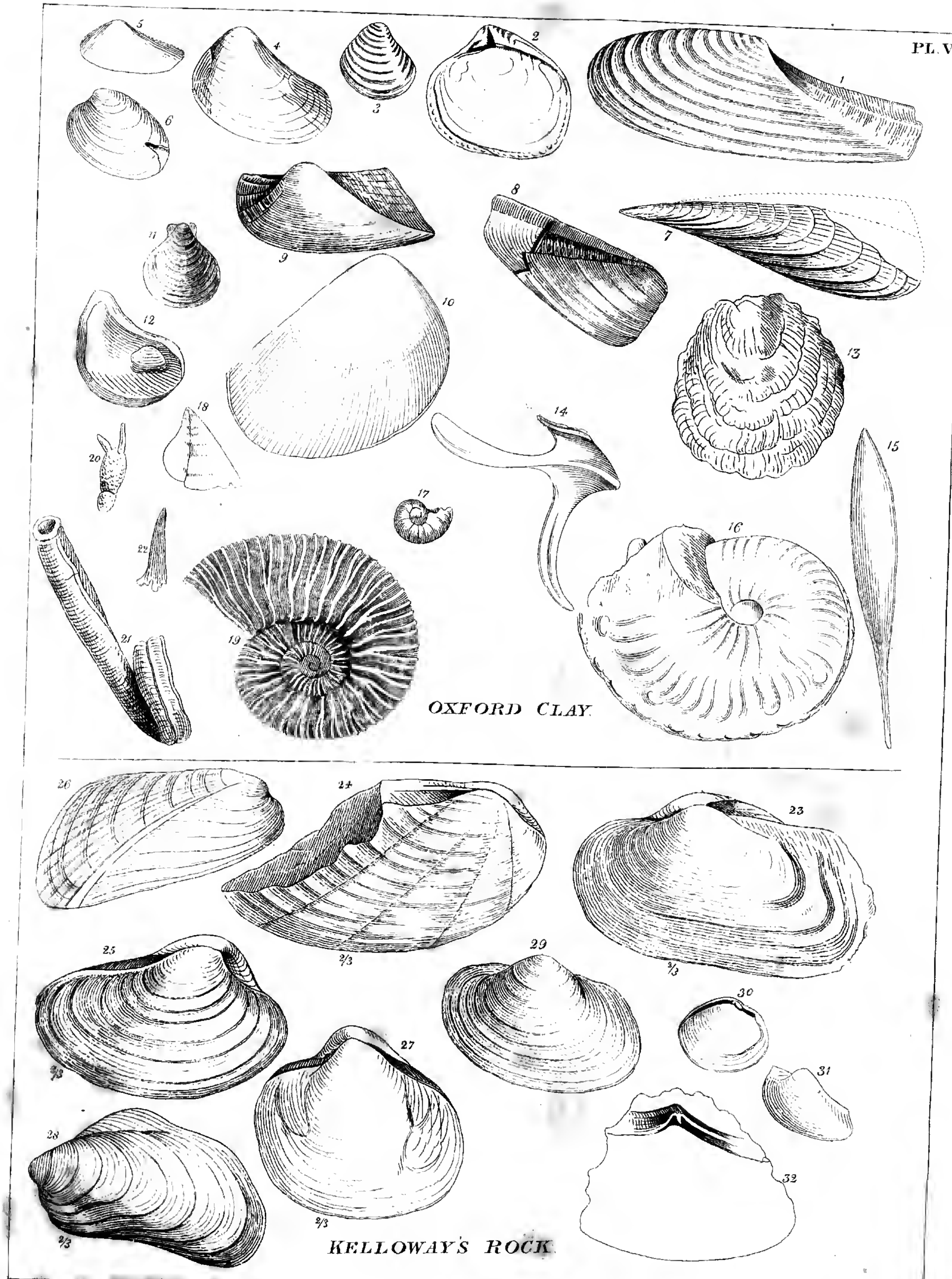


Dawson & Brown York



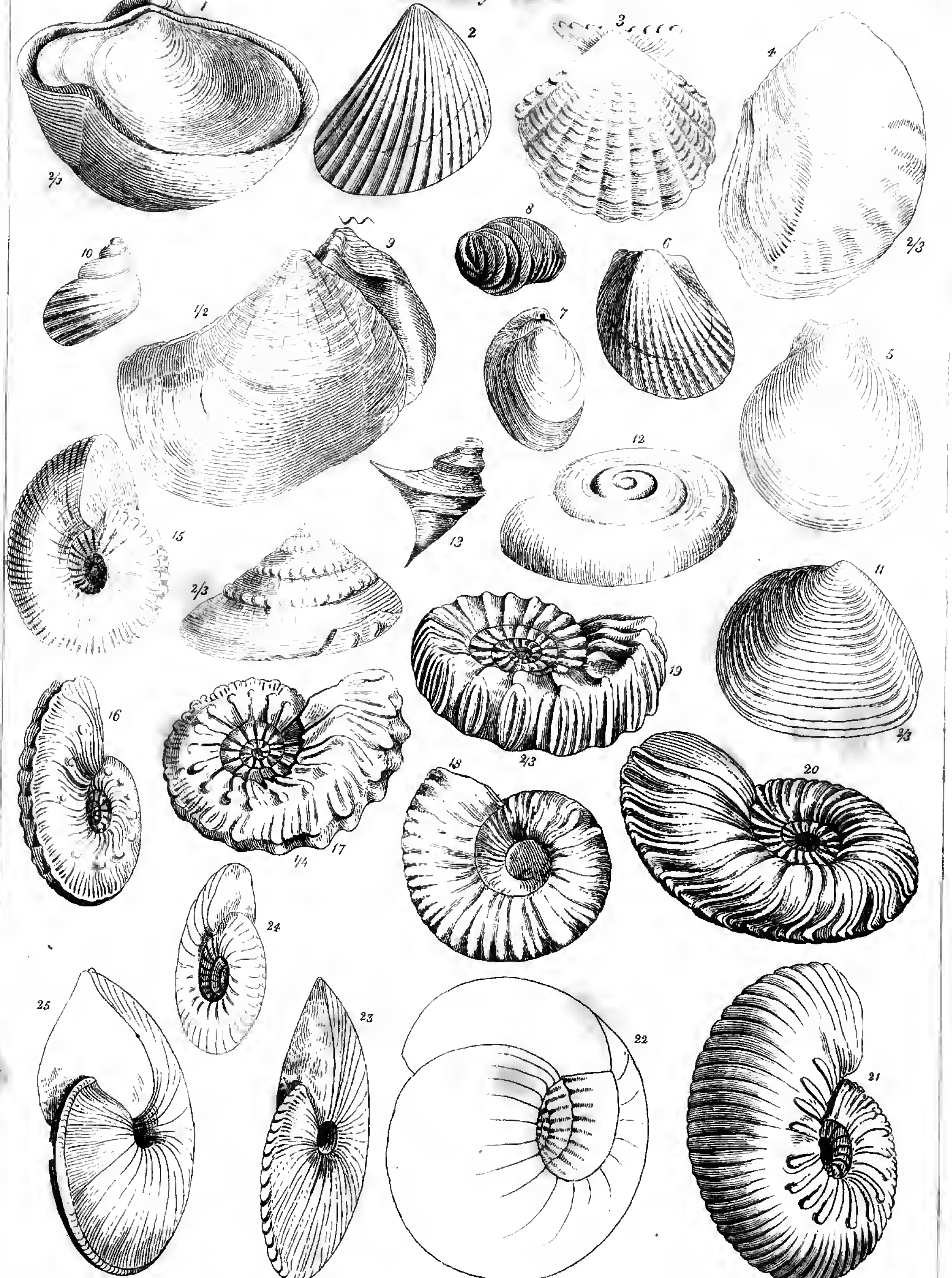
Drawn by J. Phillips.

Dawson & Brown sc York.



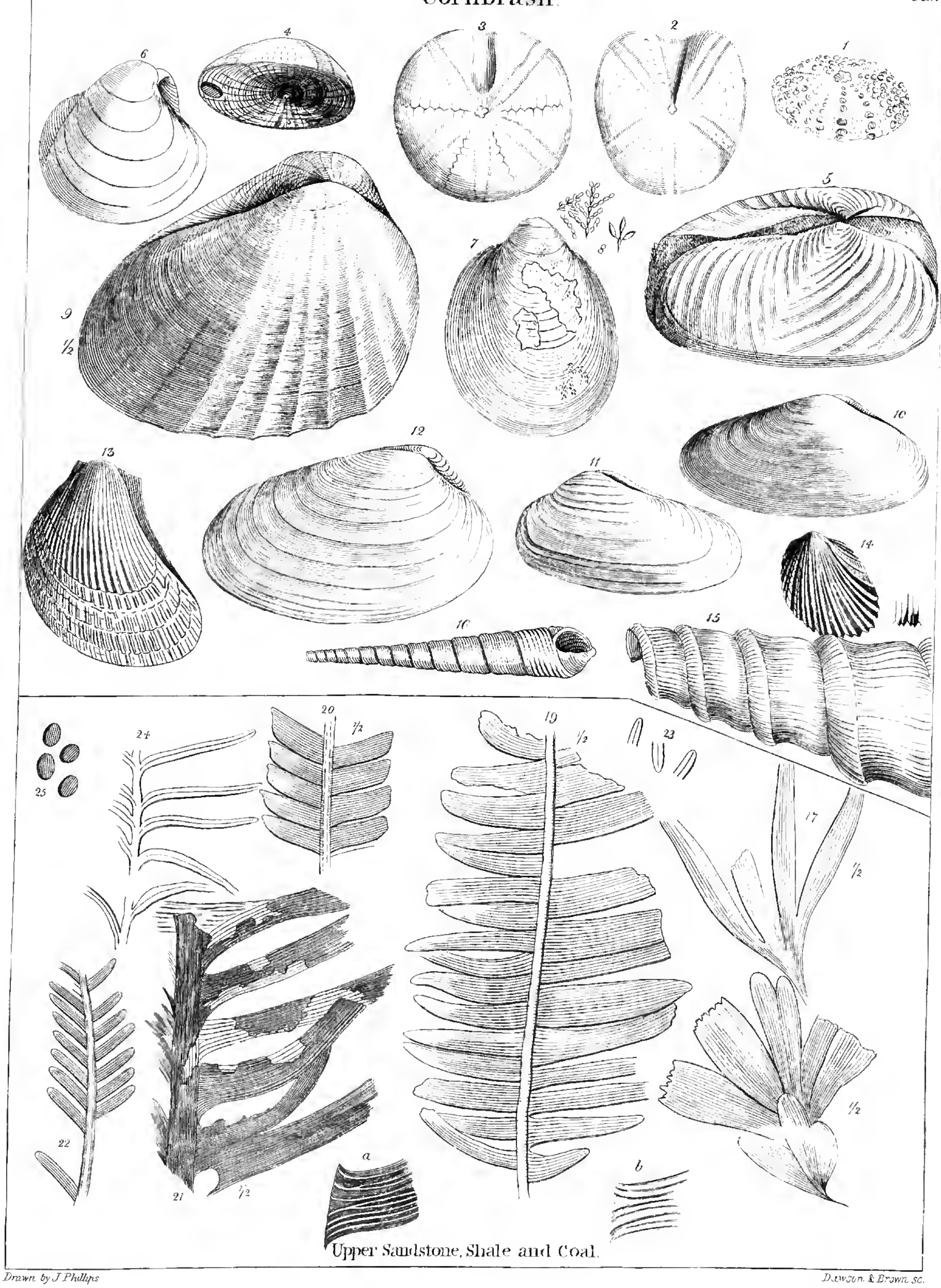
Drawn by J. Phillips. Dawson & Brown York

Kelloways Rock. PL. 6



Drawn by J. Phillips — *Dawson & Brown sc.*

Cornbrash. PL. 7



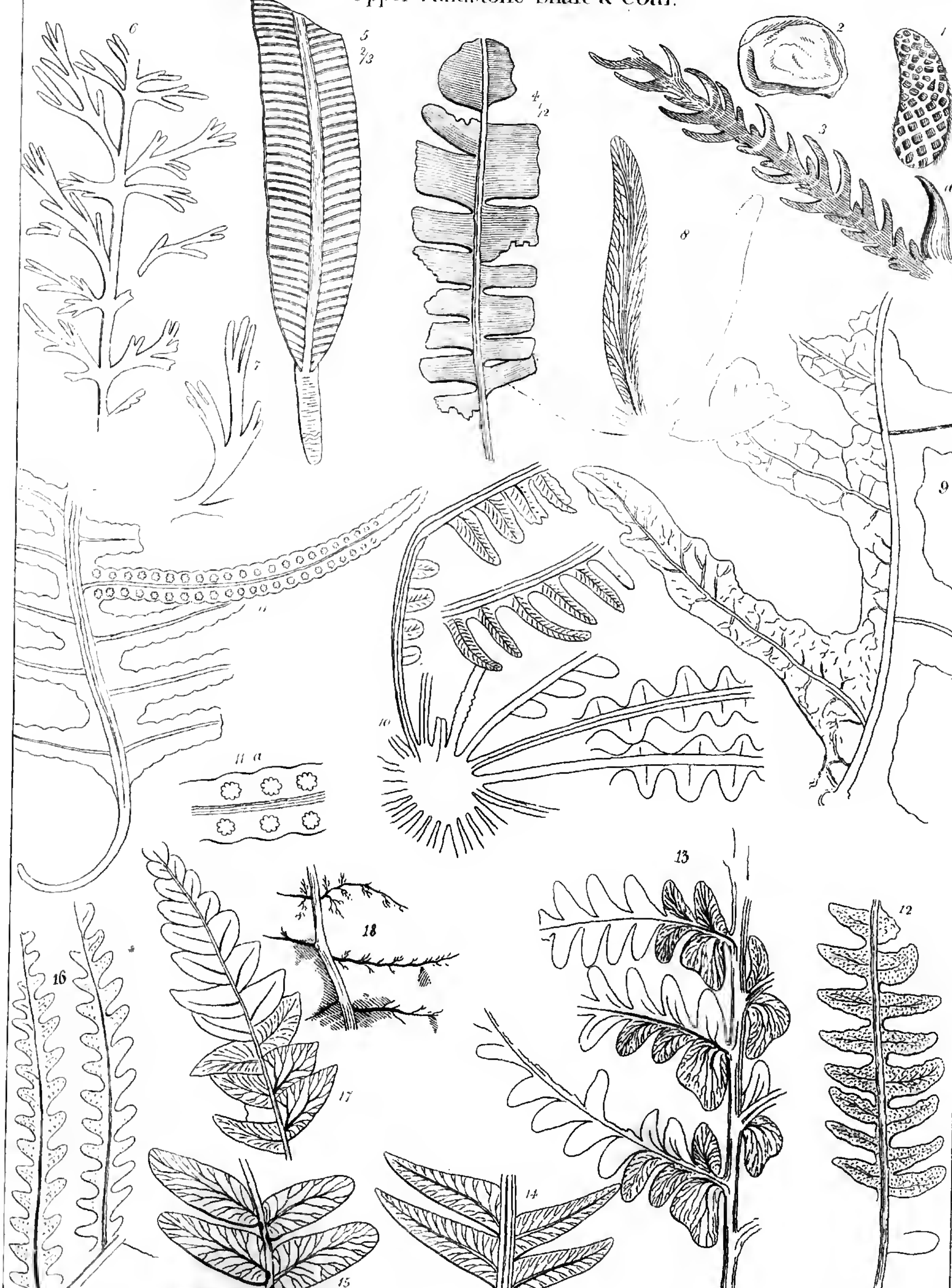
Upper Sandstone, Shale and Coal.

Drawn by J. Phillips

Dawson & Brown sc.

Upper Sandstone Shale & Coal.

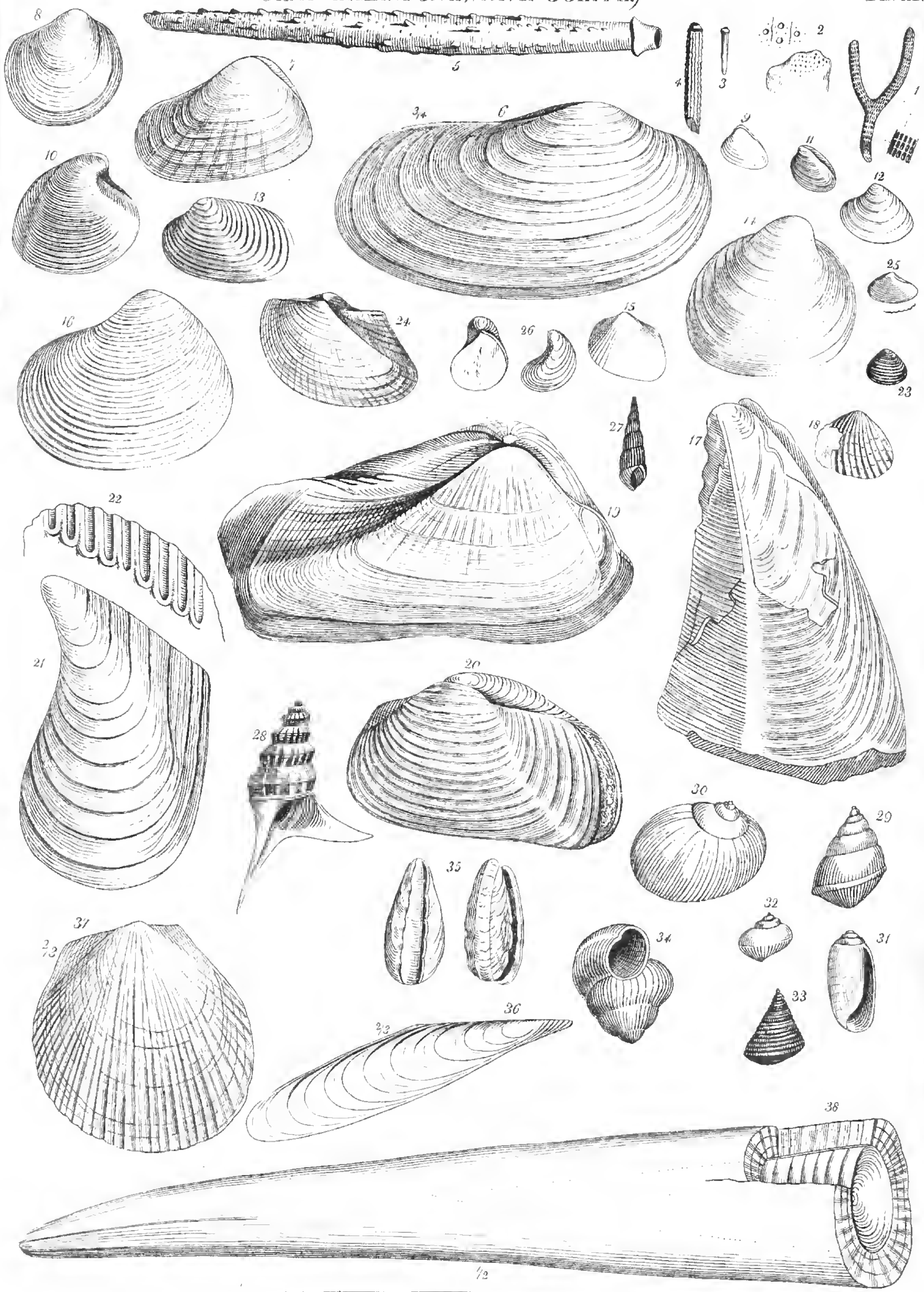
Pl. VIII.



J. Phillips

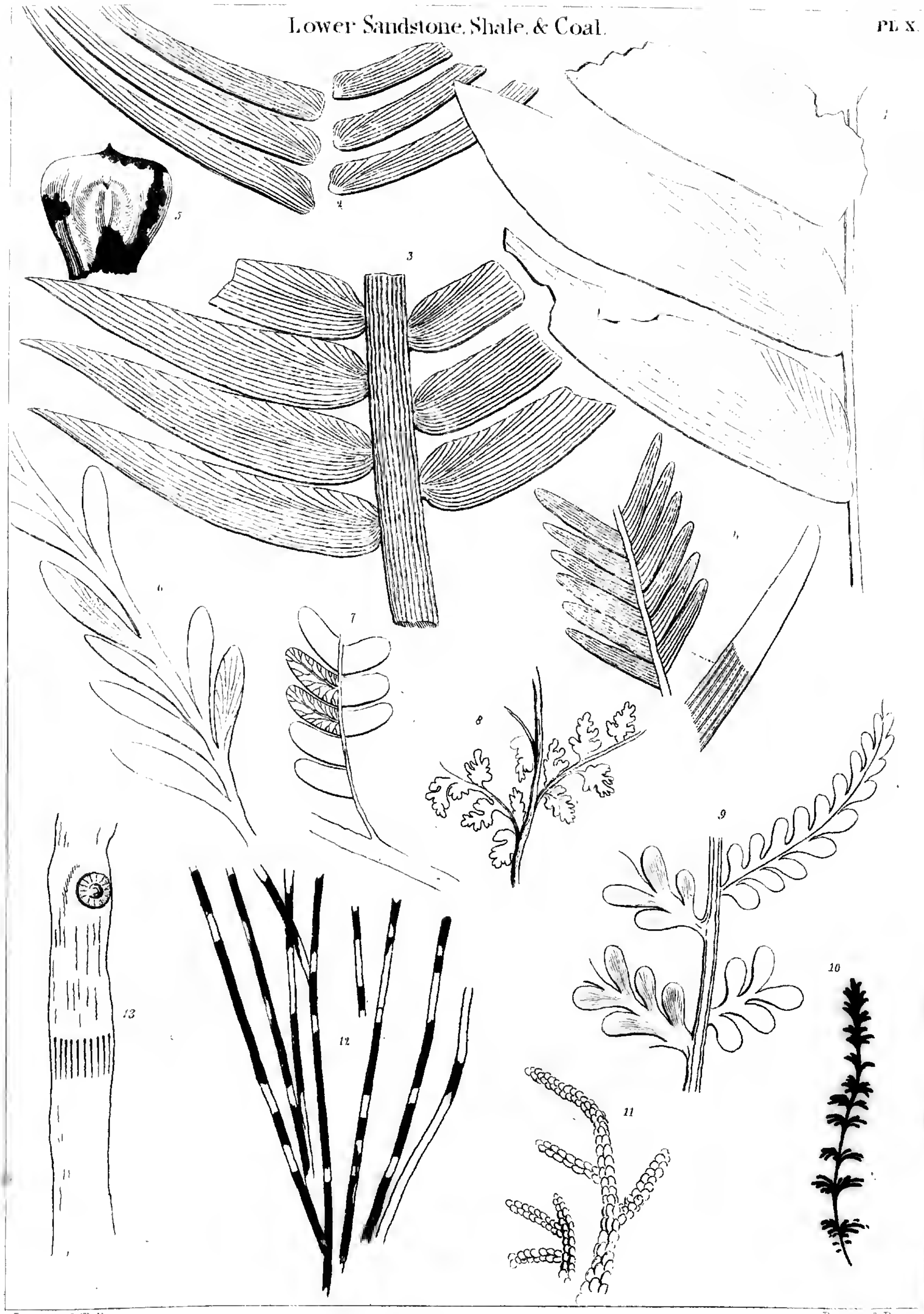
Dawson & Brown, sc.

GRAY LIMESTONE, (CAVE OOLITE.) PL. IX.



Drawn by J. Phillips

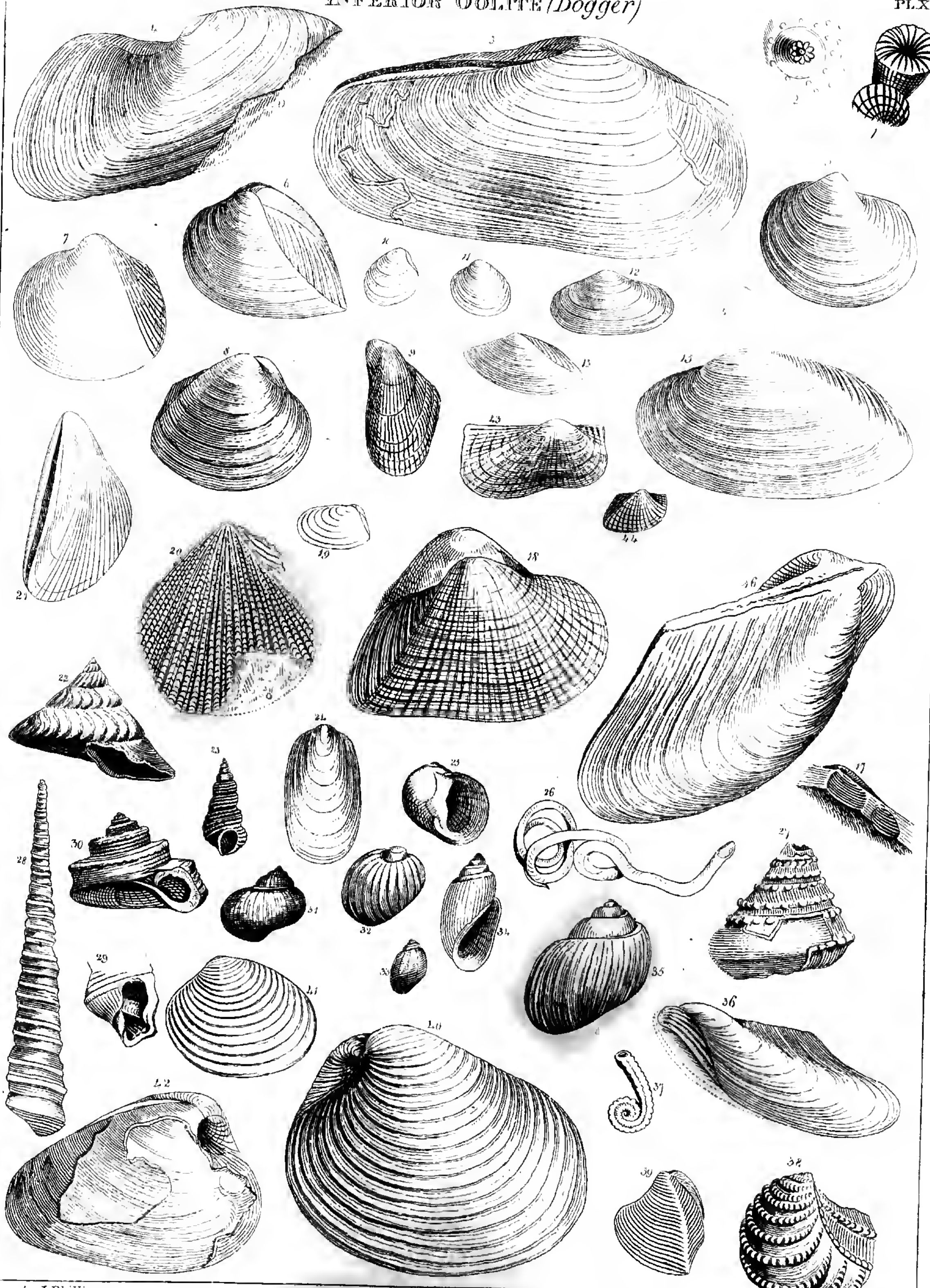
Dawson & Brown sc York



Drawn by J. Phillips.

Da & Brown sc.

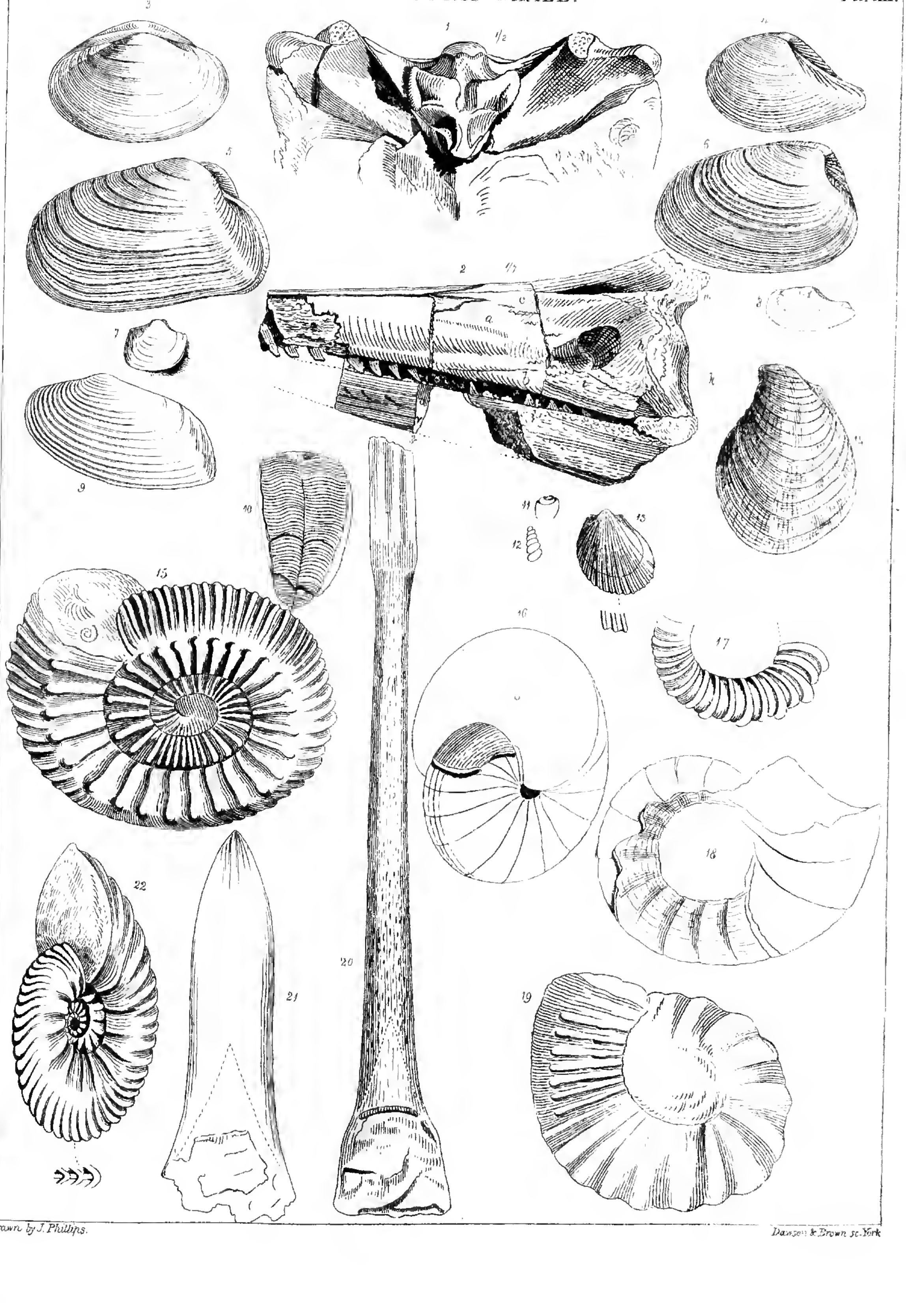
INFERIOR OOLITE (Dogger)



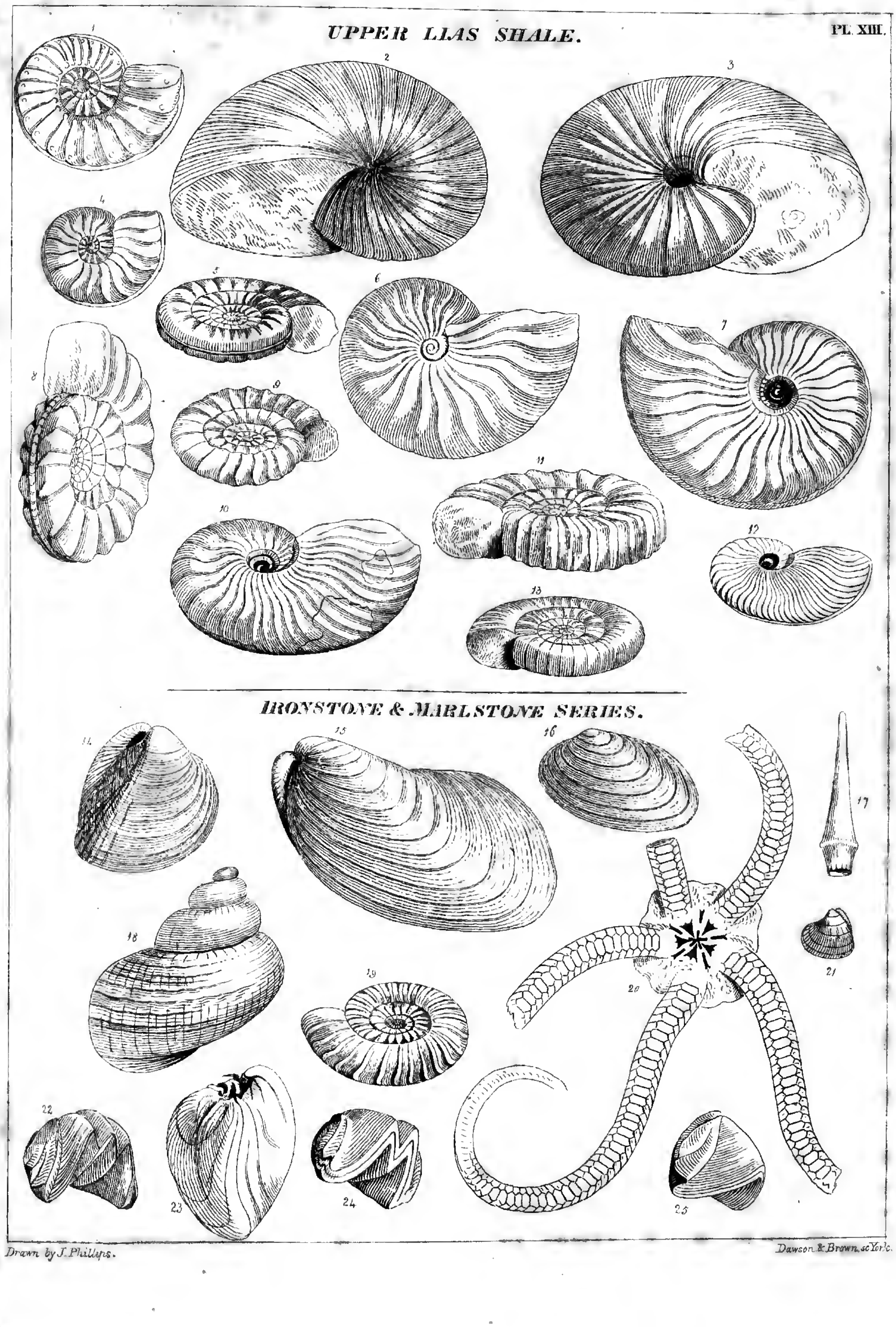
Drawn by J. Phillips.

Dawson & Brown sc York.

UPPER LIAS SHALE. PL. XII.

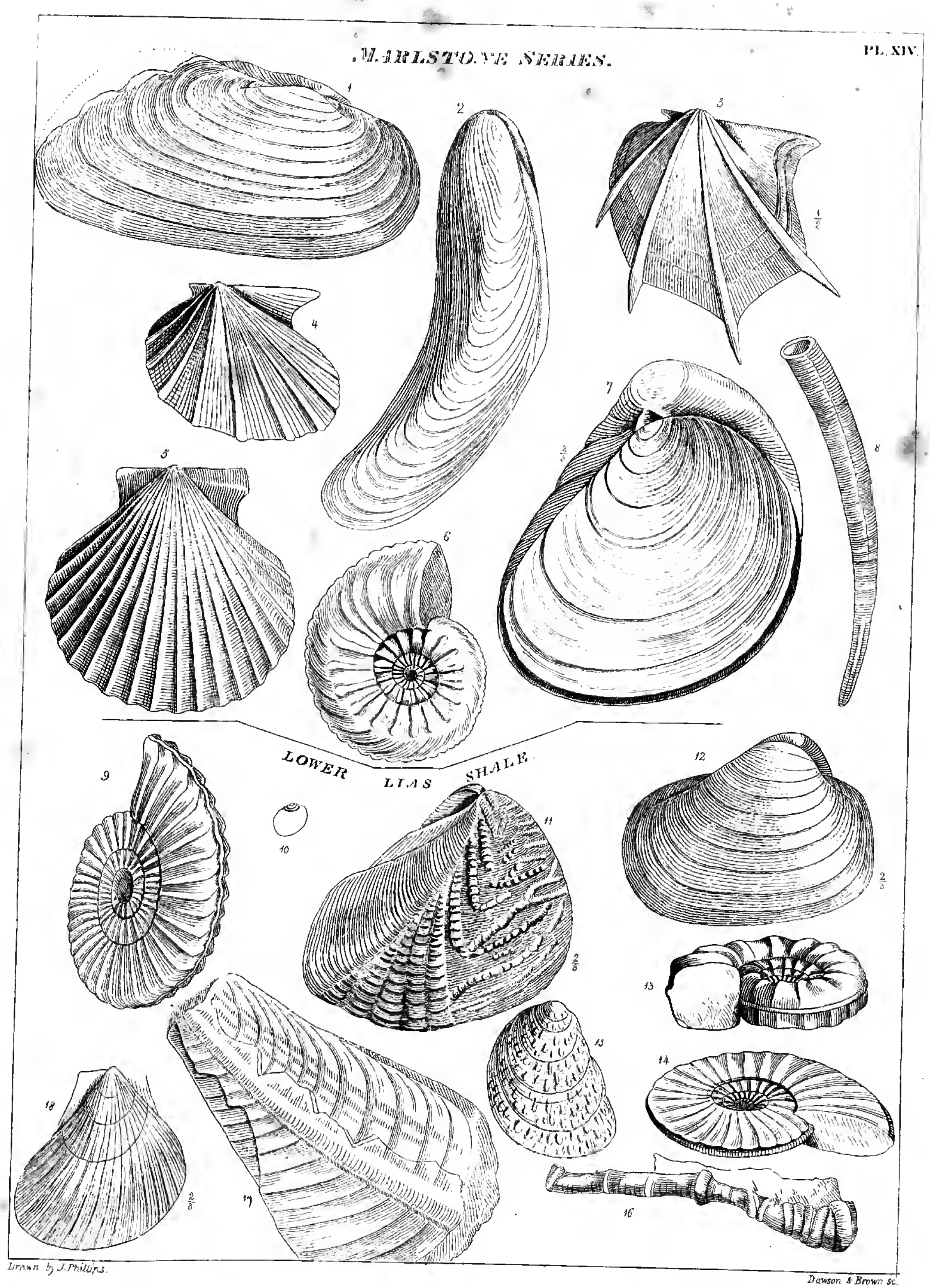


Drawn by J. Phillips. *Dawson & Brown sc. York*



Drawn by J. Phillips.

Dawson & Brown, sc York.


MARLSTONE SERIES.
PL. XIV.
LOWER LIAS SHALE.
Drawn by J. Phillips.
Dawson & Brown sc.